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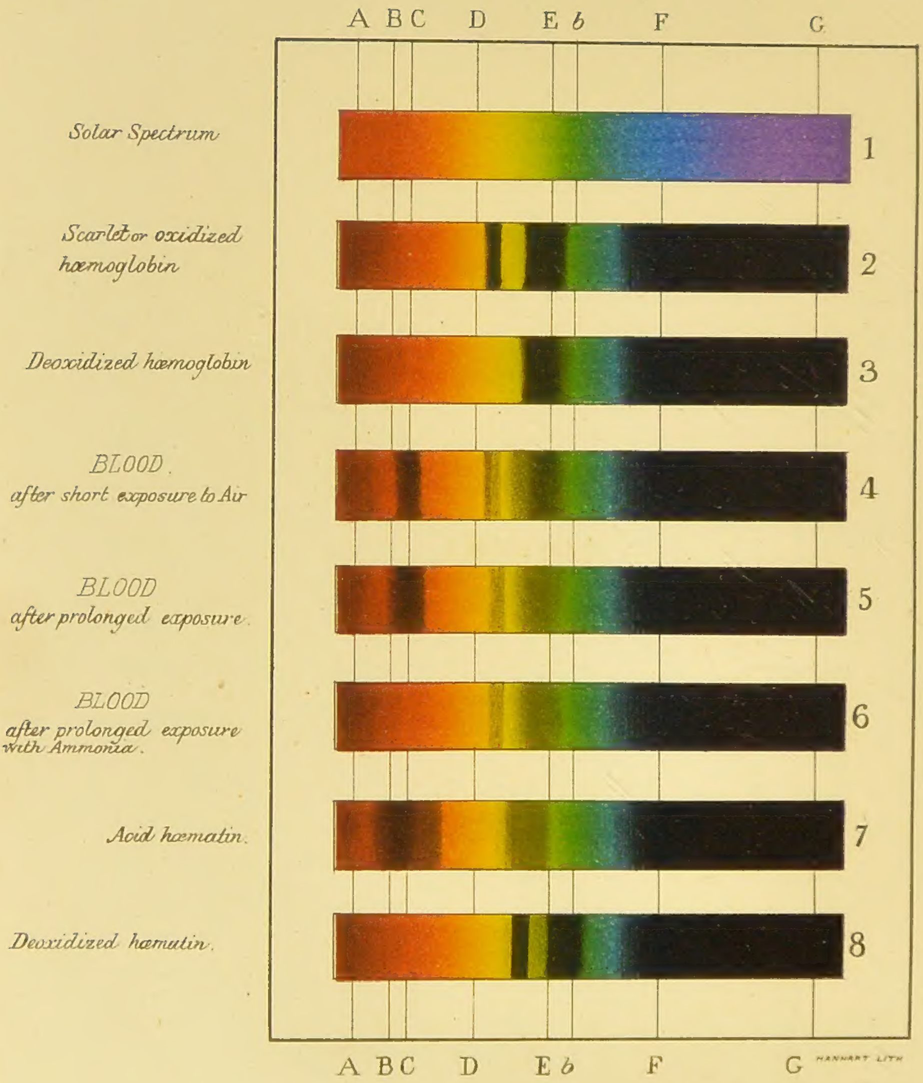

HANHART LITH

BLOOD SPECTRA.

A HANDY-BOOK

OF

FORENSIC MEDICINE

AND

TOXICOLOGY

BY

W. BATHURST WOODMAN, M.D., F.R.C.P.

ASSISTANT PHYSICIAN TO THE LONDON HOSPITAL; PHYSICIAN TO THE NORTH-EASTERN HOSPITAL FOR CHILDREN; EXAMINER AT APOTHECARIES' HALL; LATE CO-LECTURER ON PHYSIOLOGY AND HISTOLOGY AT THE LONDON HOSPITAL; ETC., ETC.

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COGNOSCETIS VERITATEM ET VERITAS LIBERABIT VOS.

Ὡς οὐδὲν ἡ μάθησις, ἢν μὴ ΝΟΥΣ παρῇ.
MENANDER.

"Sunt bona, sunt quædam mediocria, sunt mala plura.
Quæ legis hic: aliter non fit, Avite, liber!"
MARTIAL.

LONDON:
J. & A. CHURCHILL, NEW BURLINGTON STREET.
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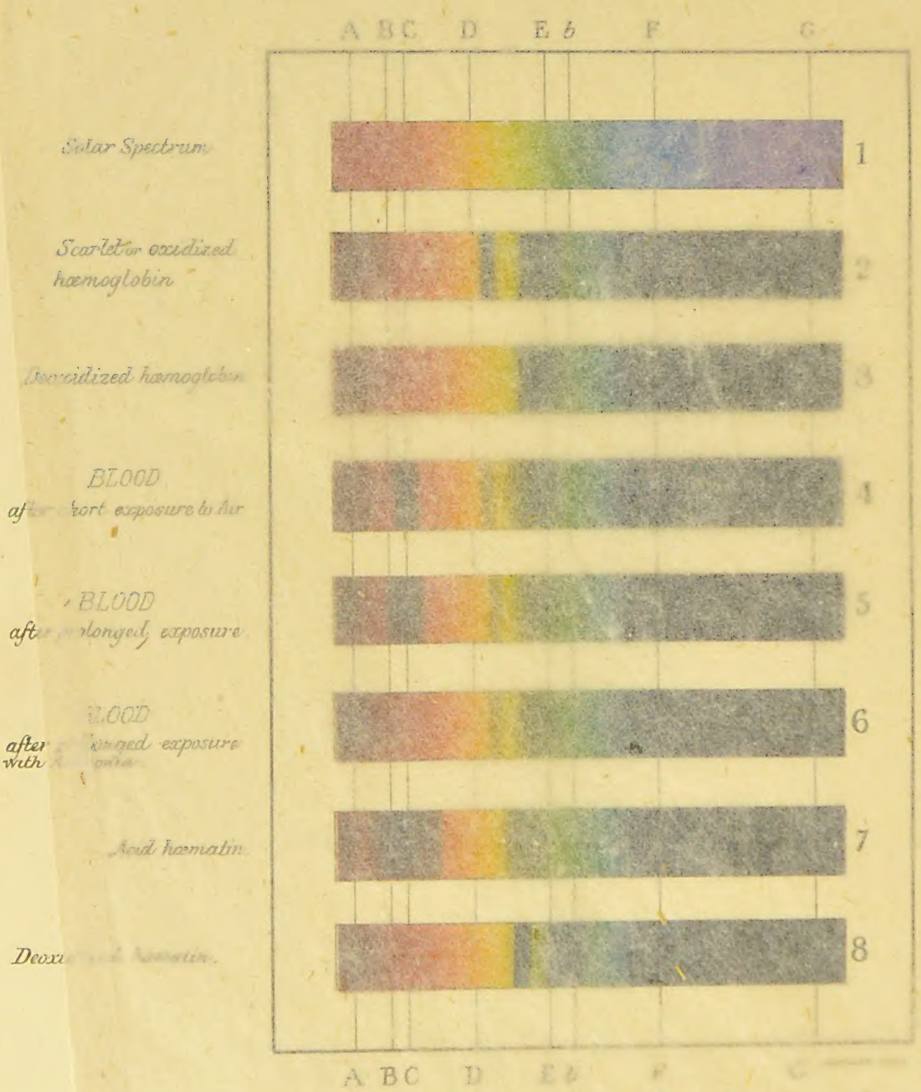
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2
Deoxidized hæmoglobin
3
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4
BLOOD after prolonged exposure
5
BLOOD after prolonged exposure with Ammonia
6
Acid hæmatin
7
Deoxidized hæmatin.
8
A B C D E b F G

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In Memory

OF

HENRY LETHEBY

PREFACE.

This Manual is from first to last a joint production, the Authors holding themselves, in each and every particular, mutually responsible.

It claims to be simply a comprehensive Medico-legal Handybook. It does not claim to be a complete treatise.

Although its subject is legal medicine, it deals with the medical rather than with the legal. The Authors have felt that lawyers know the legal aspect of the subject better than physicians, whilst physicians know the medical better than lawyers. Recognizing, however, the existence of a part of the subject belonging to both lawyer and physician, but special to neither, they have ventured on this mid-territory, trusting that their medical view of the land in question may be found of service to those whose profession leads them to regard it primarily from a different point of view.

It may be desirable to mention that in describing chemical reactions, the Authors have usually adopted the trivial names for reagents rather than a strictly scientific nomenclature. This they have done advisedly, since in all probability the work will be as frequently used by those unfamiliar with modern chemistry as by the chemical student. The same remark explains the use of Fahrenheit degrees and avoirdupois weights in place of the Centigrade and Metric systems.

The Authors are greatly indebted to numerous friends for suggestions, and in many cases for material assistance. Amongst others must be specially mentioned, Mr. H. C. SORBY, F.R.S., for his help in the chapter on blood, Dr. ROBERT BARNES, Mr. HUTCHINSON (whose name was unfortunately omitted from the history of his own discovery of notched teeth at p. 728), Dr. LANGDON DOWN, Dr. JOHN RANDALL, Mr. WAREN TAY, and Dr. J. S. STOCKER, Mr. NEEDHAM (for drawing the plates of hairs), and Mr. MIDWINTER. They must, moreover, express how much they are indebted to the late Dr. LETHEBY for help and assistance in ways far too numerous to mention.

The Authors desire to express to the Messrs. CHURCHILL their thanks for the liberal manner in which they have met them in the matter of illustrations.

As a matter of course the Authors have made free use of the standard works on legal medicine. To acknowledge at every point how much they have been indebted to the elaborate works of ALFRED SWAINE TAYLOR, CHRISTISON, ORFILA, TARDIEU, BECK, CASPER, GUY, and WORMLEY, would have involved mentioning their names on almost every page. The titles of their works will be found in the Bibliography appended. The brevity of this list is compensated in some measure by frequent references in the text, and in the foot-notes.

That unavoidable mistakes in so complicated a work will have crept in, notwithstanding every care to prevent them, the Authors cannot for one moment doubt. They trust some excuse will be found in the fact that the Manual has been written amidst the demands of professional work.

Lastly. They dedicate this book to the memory of their late colleague and former teacher, Dr. LETHEBY. During his life he had taken a deep interest in its progress, and had given permission for the work to be dedicated to him. He had, moreover, consented to write an introduction. And now he is gone the Authors sorrowfully dedicate it to his memory, not merely in recognition of his having been one of the greatest English authorities on its subject-matter, nor as an acknowledgment of numerous acts of personal kindness, but more particularly as his pupils, whose first lessons in Forensic Medicine were his lectures, and in testimony of that to which a long race of London Hospital Students can bear record, his ever ready willingness to teach, as well as his rare aptitude in imparting the knowledge he himself possessed in so profound a degree.

C. MEYMOTT TIDY,
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W. BATHURST WOODMAN,
6, Christopher Street,
Finsbury Square.

March, 1877.

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A HANDY-BOOK

OF

FORENSIC MEDICINE & TOXICOLOGY.

CHAPTER I.

INTRODUCTORY.

The Coroner's Court—Inquests—The Superior Courts—Medical evidence—Fees legally claimable by medical men.

Forensic Medicine, or Medical Jurisprudence, may be said to include every branch of Medical Art, and every fact in the wide domain of Medical Science. A medical witness in a court of law may be asked questions the correct answer to which may presuppose an almost omniscient acquaintance with the facts and theories of Anatomy, Chemistry, Medicine, Surgery, and Obstetrics, and we may even add Technology; in order to the detection of crimes of all kinds, including the adulteration of food, and the complicated manœuvres of the forger and the coiner. It is almost self-evident that such a "circle of the sciences," even if the authors were accomplished enough to undertake so gigantic a task as the digest of the whole, could never be comprised within the limits of a "handy-book." Toxicology alone has now a voluminous literature of its own, and is justly considered to be a special division of the subject. This wide field of study, and the great length of the works which have been written upon it, deter many students and practitioners of medicine from undertaking the study of the relations of their art to the requirements of justice in civilized communities. They fear to begin the study of forensic medicine because it appears to them a labyrinth of undigested facts and theories far too bewildering for men of average abilities and ordinary leisure. The evils of this state of things are at least twofold. First, many students are rejected at examinations solely on account of their shortcomings in this subject; and secondly, many medical practitioners are conscious of painful and ridiculous exhibitions of ignorance in courts of law: ignorance which it is to be feared has too often led to a failure of justice. The object which the authors propose to themselves in this handy-book is to exhibit briefly the outlines of the current knowledge of the day on those topics which are most frequently the subject of enquiry, and sometimes of controversy, during civil or criminal trials.

Some of the chief practical issues which are to be decided by medical witnesses are :—

1st. Questions of personal identity of the dead or living.
2nd. The fact of death itself; and
3rd. The cause of death, whether by the ordinary course of nature, disease, or violence (poison, or otherwise). If by any of these, what are the proofs?
4th. The questions of pregnancy, and its duration; legitimacy, and the capacity for procreation; and the proofs, if any, of crimes committed against morality and social order.
5th. Disputed claims as to life insurance and survivorship.
6th. Questions of malingering, and feigned diseases, and the capacity of prisoners to undergo certain sentences.
7th. Questions of mental soundness, or insanity. The capacity to make a will, or to manage one's own affairs.
8th. More rarely the questions of forgery of documents, and adulterations of food and medicine, and
9th. Questions of malapraxis.

The Coroner's Court. Inquests.

The first court to which you will probably be summoned, as a medical witness, is the Coroner's, the proceedings at which are generally known as an Inquest. The summons you will receive should be in the form subjoined :—

> "*Coroner's inquest at the* *in the parish of* *in the county of* *upon the body of*
>
> "*By virtue of this my order, as Coroner of* *you are required to appear before me and the Jury at the place aforesaid, on the* *day of* *one thousand eight hundred and* *at* *of the clock in the* *noon, to give evidence touching the cause of the death of the aforesaid person; and make, or assist in making, a post-mortem examination of the body (with an analysis of the contents of the stomach, if such be necessary), and report thereon at the said inquest.*
>
> "*A.B.,*
> "*To Mr.* "*Coroner.*"

Unless the summons be worded as above, it is not considered a *medical* summons.

You may receive this notice only a few hours, or even less, before the time fixed for the Inquest. However short the notice, it is not safe to disregard the summons, as neglect not only entails a penalty of £5, but in the event of the case being carried into the criminal courts, you may lay yourself open to a reprimand from the presiding judge. The only legal excuse for your non-attendance is a summons for the same hour from one of the superior courts. It may, of course, happen that a medical man might be morally justified in refusing to leave a case involving risks to life, but such cases will of necessity be exceedingly rare.

The Coroner's Court is one of great antiquity, and the statute upon which the proceedings are chiefly founded dates back to the 4th year of Edward I. (statute 2). The Coroner, who is supreme judge in his own court, can issue a summons for the attendance of any legally qualified medical practitioner. You must not, therefore, refuse to go, *merely because you know nothing about the case.* Your opinion may be required as a skilled witness upon collateral issues of fact or opinion. The ordinary fee for a medical witness is one guinea. You cannot legally refuse to make a post-mortem examination, if the Coroner requests it, and you cannot claim more than two guineas for your attendance, and the autopsy, including a chemical analysis of the stomach, &c. But if you do not feel competent to make the analysis you ought to say so, and refuse to perform in a hasty and improper manner that which may involve not only the life but the reputation of others. A Coroner may ask you to make a post-mortem examination *whilst* the inquest is being held, and by artificial light. You ought to protest against this, as it is impossible to make a careful examination of the whole body in less than an hour, and if it be possible, daylight is always preferable. The yellow tinge given to the skin by certain poisons (picric acid, *e. g.*), and the same tint produced by disease (*e. g.*, jaundice), may easily escape notice by candle or gas-light. The principles which should guide you in giving evidence in the superior courts are applicable at inquests, and we shall, therefore, state them briefly in this chapter :—

I. Make yourselves as fully acquainted as possible with all the facts of the case on which you have to give evidence. Let your post-mortem examination be a thorough one. (*See* Chapter II.) Do not, for example, make so serious a mistake as to neglect the examination of the *head* because the death was a sudden one, and you found *heart*-disease. Death is sudden in some cases of cranial hæmorrhage, and remember apoplexy may co-exist with, or be caused by, poisoning. Carefully examine the clothing, if any, and all the surroundings of a dead body. You should also refresh your memory by a reference to some standard work on the subject, so as to know the views held by authorities. Even should your own opinion be the more correct one, it is not fair to an inculpated person to give it as if there were no other, when professional men of eminence may hold an opposite view to your own.

II. Be punctual to the time appointed for the enquiry.

III. Avoid all flippancy of manner. Possibly the inquest may terminate in a verdict of manslaughter or murder, and the case will then go for trial before a superior court. But even if no such serious issues are at stake, your own sense of propriety must lead you to spare the feelings of the relatives or friends of the deceased as much as possible, and to respect yourself and your oath by a decent and suitable behaviour. At the same time, a man's natural manner is the best, and we deprecate all assumption of preternatural gravity.

IV. Arrange what you have to say (especially the symptoms observed during life, and the post-mortem examination) in a methodical manner. *You cannot be too clear about dates.* It is well to affix the day of the week, as well as that of the month, to every important event.

Measurements, and the sizes and distances of objects, should be given either from well-known standards, such as parts of an inch, foot, yard, and the like, or you may use, though less definite, such expressions as a finger's or hand's breadth. You may also compare the sizes of things with well-known objects, such as a sixpence or a shilling.

In descriptions of injuries, it is better to take some bone (as a rib) for a starting point, than a more variable object like the nipple.

V. Use the plainest English you can, and never strive to appear learned by the use of scientific or cant terms. Let the result of a blow be a *bruise* rather than a contusion; speak of a *blood-clot* rather than of apoplectic extravasation.

VI. Do not answer any question unless you both hear it and clearly understand it; and take care to give your own evidence so as to be heard and understood. Your evidence given in a village inn may be read and commented upon by the medical and legal professions throughout the world.

VII. Never lose your temper in the witness-box. Your best method of defence, if unduly pressed, is to be as cool and imperturbable as possible.

VIII. Avoid prolixity and useless repetitions. Volunteer as little evidence as possible; but keep back no part of the truth, when issues are plainly put to you, as nothing can be more damaging to a case, than the appearance of shuffling or evasion in a witness. A medical or indeed a scientific witness, should never show himself a mere partisan. You should, therefore, rather answer questions than volunteer statements in the majority of cases.

IX. Keep your *opinions*, together with all disputed circumstances, quite separate from those *facts* which you have yourself observed, or which are satisfactorily proved by the evidence. Thus there can be no reasonable doubt that belladonna and prussic acid are deadly poisons in certain doses, whilst the precise manner in which they kill is as yet uncertain. Again, in a case of cut-throat, the direction of a wound and its dimensions are simple matters of fact; but the deduction that the wound in question was inflicted by a left-handed person or was homicidal or suicidal, will in many cases be a matter of opinion.

X. Whilst avoiding undue hesitation, as you would avoid undue precipitancy, take time so to frame your answer, that it may convey your real meaning, and be easily understood. The use of exaggerated expressions should be avoided. For example, we once heard two medical men swear that in a given case there was an *enormous* quantity of fluid in the pericardium; but on being pressed as to the quantity, they admitted there was only *about two ounces.*

XI. The law is very strict on the point of written notes. The witness is not allowed to read his evidence, although he is allowed to refresh his memory by referring to his notes. Further, all notes referred to in the witness-box must have been made at the time to which they refer, or immediately after; and if the notes themselves are to be admitted as evidence, they must be the originals, and not copies. You may not unreasonably ask, "Am I at liberty to *quote* authorities in the witness-box?" Opinions differ as to the admissibility of evidence from books. As a rule, judges do not favour this, since you are called for your own knowledge of facts, or your own opinions. Dr. Taylor states, very justly, that you ought to verify all assumed "quotations," before assenting to, or dissenting from them, as counsel may either wilfully, or by mistake, misrepresent the author from whom they quote. Do not let any authority, however eminent, shake you on simple matters of fact.

Take care that your depositions are read over to you before signing them.

XII. The highest legal authorities have decided that there is no special privilege attaching to medical men with regard to secrets of a professional nature. In other words, no practitioner can claim exemption from answering a question, because the answer may involve a violation of secrecy, or implicate the character of his patient or friend. This is the law; and however it may be defended on legal grounds, we hope that there are many medical men who would prefer to sacrifice their personal liberty to their honour. For it seems a monstrous thing that secrets affecting the honour of families, and perhaps confided to a medical man in a moment of weakness, should be dragged into the garish light of a law court. Our duty here, however, is simply to state the law.

The Superior Courts: Subpœnas.

Supposing the case in which the inquest has been held ends in a verdict of manslaughter, or murder, you will probably have to appear at a police court, or before magistrates, and you will then be bound over to give evidence on the trial. Of this you will receive due notice. A sum of £20 or £40 is usually named as a penalty for non-attendance. No medical man is bound to attend a trial unless a subpœna has been placed in his hands a reasonable time beforehand. In civil cases a payment of some kind is needed to make the subpœna binding. It is generally in the form subjoined, which differs but little from that used in the criminal courts:—

VICTORIA, by the Grace of God, of the United Kingdom of Great Britain and Ireland, Queen, Defender of the Faith, To Greeting; We command you and every of you, that all things set aside and ceasing every excuse, you and every of you be and appear in your proper persons before our Justices assigned to take the Assizes in and for the County of at in the said County, on the day of by Nine of the Clock in the forenoon of the same day, and so from day to day, until the Cause hereinafter mentioned be tried, to testify the truth according to your knowledge, in a certain Action now in our Court before at depending between Plaintiff and Defendant on the part of the and at the aforesaid day by a Jury of the Country, between the parties aforesaid, in the Action aforesaid to be tried; and this you nor any of you shall in no wise omit, under the penalty of every of you of One Hundred Pounds. Witness, at Westminster, the day of in the year of our Reign.

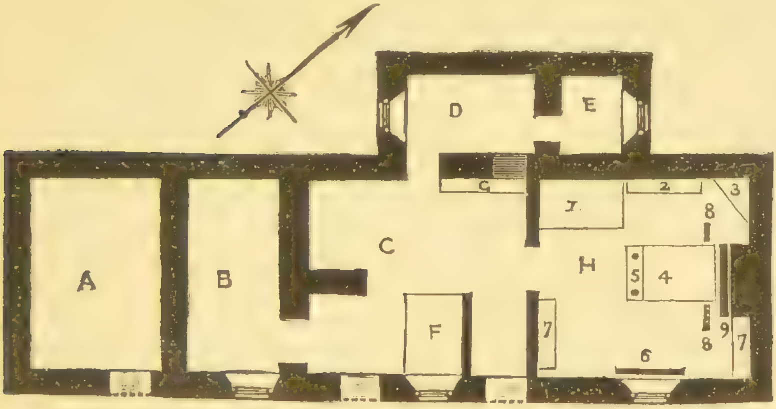
A professional witness should ask for and obtain his reasonable expenses; and he is not bound in a civil trial, nor always in a police court, to give evidence until so paid. But when once sworn, he cannot legally refuse to give evidence as to matters of fact. If you are subpœnaed to both a civil and criminal case at the same time, you should attend to the criminal one, giving due notice to the counsel on the other case. If both subpœnas are for similar courts, then the monition from the Superior Court must have the first attention. If from two Courts of equal authority, then the summons first received should be obeyed. You cannot recover any fees unless you are duly registered. The following are the fees legally claimable by medical men summoned as witnesses when there is no special agreement as to fees. (*See* "A Manual of the Laws affecting Medical Men," by R. G. Glen, LL.B., Barrister-at-Law. Churchills.) :—

In the Superior Courts, and in Equity, £1 1*s.* a day, if resident in the town in which the cause is tried; £2 2*s.* to £3 3*s.* a day, if resident at a distance from the place of trial, inclusive of all except travelling expenses. If the witness attend in more than one cause, he is entitled to a proportionate part in each cause only. For travelling expenses, the amount reasonably and actually paid is allowed, provided it does not exceed 1*s.* per mile one way. In the Probate Court, £1 1*s.* a day, if resident within five miles of the General Post Office; £3 3*s.* a day, if resident beyond that distance (including board and lodging). The same allowance for travelling expenses as in the Superior Courts. In the Divorce Court, £1 1*s.* a day, if resident within five miles of the General Post Office. From £2 2*s.* to £3 3*s.* a day, if resident beyond that distance (including board and lodging). The same allowance as in the Probate Court for travelling expenses. In the House of Lords, physicians and surgeons £2 2*s.* a day, and £1 1*s.* a day for hotel expenses if from home. Apothecaries £1 1*s.* a day, and the same allowance for hotel expenses. Higher charges are allowed under special circumstances. Sundays do not count as time. The sum necessarily expended is allowed for travelling expenses. In the County Court, from 10*s.* to £1 a day. For travelling expenses, the sum reasonably paid, not more than 6*d.* a mile one way. In the Admiralty Court, from £1 1*s.* to £3 3*s.* a day (including board and lodging). The same allowance as in the Superior Courts for travelling expenses. In the Bankruptcy Court, £1 1*s.* a day, if resident in the town in which the Court is held. From £1 1*s.* to £3 3*s.* a day, if resident at a distance from the Court (including subsistence). Travelling expenses 7*d.* a mile one way, where no railway is available, or expenses actually incurred. In the Lord Mayor's Court, 10*s.* 6*d.* to £1 1*s.* a day, and the same allowance for travelling expenses as in the Superior Courts. The expenses of witnesses in most cases of misdemeanor, and in all cases of felony, are now allowed. On an examination before a magistrate, a sum not exceeding 10*s.* 6*d.* may be allowed to a medical witness residing in the city, borough, or parish where the examination takes place, or within two miles thereof, and to such a witness residing beyond that distance a sum not to exceed £1 1*s.* For mileage, a sum not exceeding 3*d.* a mile each way. Medical witnesses attending Courts of Assize, General Sessions of the Peace, &c., to give professional evidence, but not otherwise, may be allowed £1 1*s.* a day, with 2*s.* for every night they are detained from home, and for mileage, a sum not exceeding 3*d.* a mile each way. Every legally qualified practitioner who has attended at a Coroner's inquest, in obedience to a Coroner's order, is entitled to a fee of £1 1*s.* for attending to give evidence, where no post-mortem examination has been made, and to a fee of £2 2*s.* for making a post-mortem examination, and attending to give evidence. No fee can, however, be claimed for the performance of a post-mortem examination instituted without the previous direction of the Coroner. These fees are to be advanced and paid by the Coroner immediately after the termination of the inquest.

In a protracted trial it is not generally necessary that you should attend the whole of each day; but it is necessary, in order to legally claim your fees, that you should attend the Court at, or just before its first opening each day, when you can generally ascertain whether your evidence is likely to be required for that day. Fees are not recoverable from attorneys, but only from the principals in an action; and it does not appear that large fees are recoverable at all. A skilled witness should therefore take care to be paid before giving his evidence, if he has any doubts of the honour of those retaining him.

Fig. 1.

Sketch Map Referred to at Page 8.



Ground Plan (scale, $\frac{1}{16}$ of an inch to the foot).

A, cow-house; B, servants' bedroom; C, kitchen; D, back-kitchen; E, dairy; F, table; G, dresser; H, parents' and Sarah Jacob's bedroom.

1, parents' bedstead; 2, wardrobe; 3, corner cupboard; 4, the fasting-girl's bedstead; 5, head of bedstead, on which two lighted candles were placed in the evening and night-time of the last watch; 6, table; 7, 7, linen presses; 8, 8, the two chairs in which the nurses respectively sat and watched; 9, book-shelves.

[By kind permission of Dr. Fowler, from his "Complete History of the Welsh Fasting Girl," p. 50.]

CHAPTER II.

Examination of bodies found dead—Weight and size of various organs—Post-mortem digestion.

How to make a "Post-mortem" examination.

THE first thing you have to do, when called to a case of supposed death, should be to ascertain the fact of death itself. (*See* Chapter III. on the Signs of Death.) Being satisfied that the body found by you is truly a corpse, it is well to observe some *method* in the post-mortem examination. The same general rules apply to all cases in which it is considered advisable to make such an examination, even when there is no prospect of legal proceedings. And the same habit of careful minute, and methodical inquiry will be of immense service to you in cases of severe injury or accident, even when life is not extinct. Dr. Letheby has shown ("Lancet," vol. i. 1846, p. 410, &c.) that such a methodical inquiry, if you keep careful notes, will often save you much "badgering" and confusion when in the witness-box. He also points out that medical men are far too apt to draw hasty conclusions, and to assume, for instance, the reality of poisoning, on very insufficient evidence. We believe that there is much improvement in this matter in the thirty years which have elapsed since his paper was written. But there is still room for much further improvement. As regards post-mortem examinations, three or four general remarks seem desirable, before proceeding to more minute details, viz. :—

I. Before you disturb the body at all, carefully note its position, and surroundings. Very slight knowledge of drawing will easily enable you to make a rough sketch of the position of the body, especially as relates to articles of furniture, and the position of blood stains, &c. &c.

The sketch on the preceding page will illustrate our meaning.

If you feel unequal to this graphic method, you can at least describe in words, and put down measurements in feet and inches.

II. When you come to examine the body itself, proceed methodically, beginning with the outside, and going on to the inside seriatim.

III. Do not be satisfied with opening only one cavity, such as the thorax or abdomen. Let your post-mortem examination be "thorough."

IV. Let your notes, however rough, be dated, paged, and have the name and address of the deceased, or some other fact tending towards identification, clearly marked upon them—and the time (if known) which has elapsed since death.

We now come to matters of detail, and observe—

(1) That you should carefully examine and note the attitude of the body, to see if there be anything suggestive of a struggle, or violent death, by poison or otherwise. Look for weapons, and traces of blood, and for cups or bottles which may have contained poison. For example, prussic acid is often given or taken in beer, and arsenic in tea or coffee, or in solid articles of food.

(2) Is the body clothed? or wholly or partially naked? Are the clothes injured or stained?

(3) Note carefully the position of the limbs. Are they rigid? (*See* P. M. Rigidity, p. 18.) If the fingers or toes are clenched, see if there be anything held between them. Examine the nails also. In struggles, hairs or portions of skin or clothing may be found; whilst in drowning, sand or weeds may be met with.

(4) Carefully note the colour and expression of the face. Are the eyes "dreadfully staring" or "decently closed" (T. Hood)? What is the colour of the conjunctivæ? Are the pupils large, small, or unequal; Is the mouth open, or the teeth clenched? Is there froth about the mouth, or any peculiar smell? (Chloroform, prussic acid, &c.) The face will generally be livid after apoplexy, death from suffocation (hanging, &c.), or where much struggling has preceded death, or in natural modes of death in which the lungs, right heart, and venous system are much gorged. It is, however, usually pale after death from acids, even prussic acid, alkalies, most vegetable poisons, blows upon the epigastrum, and injuries to vital organs. On the other hand, in poisoning by alcohol, opium, the oxides of carbon, and chloroform, it may be either pale or red. In most violent deaths, and after severe hæmorrhages, the features are convulsed. Apoplexy, opium, carbonic acid and other narcotics, often give a calm look, whilst corrosive poisons, especially such as produce severe abdominal symptoms, frequently give a pinched and anxious expression, like the facies hippocratica.

Note the condition of the gums and teeth. Has the tongue been bitten?

(5) Now remove all clothes from the body. Carefully examine for scars, tattooings, nævi, and other means of identification. Note if urine, fæces, *semen* or any other discharge have taken place. (*See* Hanging, &c.)

(6) Now note if the body be fat or thin—take care not to mistake dropsy or gaseous distention for fat. Examine carefully for external wounds, marks of burns, blisters, &c. If you find any wounds in the throat or elsewhere, note *their direction* and depth; in other words, are they deepest from right to left or *vice versâ*; how far do they extend, and if they were prolonged in the same line, where would the knife, bullet, or other weapon emerge? If necessary, dissect carefully to see what parts are implicated. Note if there be any marks of a cord round the neck. If you find a cord, note where the knot is, front or back, as in suicide it is generally in front. Note the condition of the edges of wounds—make incisions into bruises, and note the presence or absence of blood and clots. Dr. Letheby has pointed out that wounds inflicted after death generally dry and discolour rapidly upon the edges, "acquiring a brownish parchment-like appearance."

(7) Note all circumstances tending to throw any light upon the time as well as the mode of death. The chief of them are (1) the temperature; (2) the amount or absence of rigidity; (3) the extent of putrefaction or other change. (*See* Chapter III. on Signs of Death.)

(8) You should now proceed to make an examination of the head and other organs in a systematic manner, as follows:—

First, make an incision from ear to ear across the head, down to the bone, and reflect the scalp. Before doing this, if the hair be very thick, it may be well, in a doubtful case of injury, to remove some of it, or even to shave the head. This is, however, very seldom necessary. Note the amount of blood in the scalp, and look for fractures or injuries to the outer table of the skull. Saw carefully round the skull, about half an inch above the meatus auditorius externus, remove the calvaria,* and note the condition of the dura mater. The dura mater should now be carefully cut round with a probe-pointed scissors or bistoury, and the condition of the arachnoid and pia mater noted. *Now remove the brain carefully*—note the condition of its base, and of the sinuses there, and proceed to slice the brain. The principal appearances to look for are, congestion, extravasations, such as apoplectic clots, effusion of serum or blood, lymph, pus, hydatids, aneurism or blocking of vessels, and tumours (malignant or simple).†

(9) Now proceed to the examination of the spinal cord and its membranes—sawing or otherwise cutting through the laminæ of the vertebræ on each side of the spinous processes with great caution; make sections of the cord at different parts. Carefully note the appearances (if blood wells up, &c.).

(10) Now proceed (turning the body over) to the examination of the chest and abdomen. Make a long incision from a little above the top of the sternum down to the pubes. Cut through and reflect muscles and integuments as low as the ensiform cartilage—afterwards reflect only the skin from thence to the pubes. With your thumb on the back of your knife, and its edge lateralized, cut carefully through the sterno-clavicular ligaments, and the cartilages of the ribs. In very old people, or if ossification of these cartilages has occurred, cutting pliers or a saw may have to be used. Note if blood flows freely from the cut integuments. Be very careful not to wound the large veins of the neck, &c. Reflect the sternum, and note if the lungs be collapsed or fill the chest. Are the lungs adherent? Is there any fluid in the pleural cavities, or in the pericardium?‡ Are the heart's cavities full or empty? What is the colour of the lungs? and of the blood in the heart, &c. Is it coagulated? Examine all the large vessels. Also the whole of the air-passages. It may be necessary to prolong the first incision in the skin up to the chin, then reflect the skin as far back as possible, plunge the knife in just under and below the symphysis of the jaw, so as to *emerge in the mouth*, carry it along close to the inner surface of the lower jaw on each side as far as the bone extends, then seize the tongue from below, and divide the velum pendulum palati with your knife, dragging the tongue forward all the time, then separate the pharynx, &c., and continue to make traction on the tongue till the pharynx, larynx, trachea, and œsophagus have

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* This word, which is feminine, is often written calvar*ium*, as if neuter. Dr. Mayne says it is derived from *calveo*, to be bald, because it is the part first affected with baldness. It is the anatomical name for that portion of the skull which is above the ears, orbits, temples, and occipital protuberances. Celsus uses it for the skull. Hence, too, "Calvary," "the place of a skull," in our English version of the Bible, the original being "Golgotha."

† During the examination of the head, this part should be raised. The body should be disturbed as little as possible, and a plug should be inserted in the large vessels, so as to prevent blood running out. Some recommend opening the chest first, and noting if the heart be full or empty, then opening the skull.

‡ Before removing either lungs or heart for these purposes, they must be examined *in situ*. You should examine all the large vessels, and also the *coronary arteries*. Carefully note any abnormalities of structure which may be present (as in cyanosis).

been removed. Open the larynx and trachea and look for foreign bodies, false membranes, marks of corrosion, &c. Slit up the bronchi in the same way, and make sections of the lungs.

As soon as the thorax is empty, examine further for fractures or disease of ribs or vertebræ.

(11) Now proceed to the examination of the abdomen, noting its contents, and the general appearance of the viscera and peritoneum. Look for strangulation of intestines, intussusceptions, internal herniæ, &c. If you find *blood*, look for lacerations of the liver, spleen, kidneys, &c. Never forget to examine the pelvic organs, and particularly the bladder, ovaries, and uterus. Young women sometimes die suddenly of apoplexy of the ovary or of pelvic hæmatoceles. Fatal injuries may be inflicted through the anus (Edward II.), or the vagina, or labia pudendi, and poisons have even been introduced in this way. (Ed. "Med. and Surgical Journal," vol. xxxv. p. 85.)

After poisoning by arsenic, the intestines are sometimes yellowed by formation of orpiment. Sulphuric and other mineral acids may cause a blackened or bluish appearance. Iron salts cause greenish or blackish coloration. Place a ligature around the œsophageal end of the stomach, and two around the first part of the duodenum. Remove the stomach, cutting *between the two ligatures last tied.* Note its external colour, appearance, and smell, and put it unopened into a clean bottle or jar, and seal it up for further examination. Besides sealing, it must be so labelled as to prevent any mistake. The stomach itself should afterwards be carefully examined with a lens and the finger, for solid particles of phosphorus, arsenic, corrosive-sublimate, or other poisons, for seeds and portions of leaves, crystals, pigments, or articles of food, and for the condition of its mucous membrane.

The contents of the duodenum, and of the rectum, together with the stomach, and portions of the liver, or other organs, should be put in clean wide-mouthed bottles or jars, and duly labelled and sealed. The whole of the intestinal tract must be examined. You ought to be familiar with the appearances produced by syphilis, tubercle, typhoid fever, &c., and as regards ulcers and perforations, we may remark that any person familiar with the post-mortem room, can scarcely mistake the rounded and thickened edges of chronic ulcers for the thinned and frayed condition of the perforations caused by corrosive fluids and irritant poisons. On the other hand great care should be taken not to cut or tear the organs in removal. Do not forget to examine the œsophagus as well as the mouth and pharynx. In examining the latter, great assistance may be derived from the large mirror of the laryngoscope.

The following are the average weights and measurements of the viscera in health. Some allowance must be made for extremes (either way) of height and weight. The measurements are in inches—

Heart—Adult Male -	11 oz.	Usually about the size of the closed fist (5 × 3½ × 2½).
„ Female -	9 oz.	
Brain—Adult Male -	49½ oz.	
„ Female -	44 oz.	
Spinal Cord -	1 oz. to 1¾ oz.	18 inches long.
Liver - -	50 oz. to 60 oz.	12 × 4 × 2
Pancreas -	2¼ oz. to 3½ oz.	
Spleen - -	5 oz. to 7 oz.	

Lungs—Adult Male -	45 oz.	Together.
„ Female -	32 oz.	
Thyroid body -	1 oz. to 2 oz.	
Thymus at birth - -	½ oz.	
Kidneys, together -	9 oz.	(4¾ × 2½ × 1 each).
Supra-renal capsules -	2 drams.	
Prostate gland - -	6 „	
Testicles, together -	¾ oz. to 1 oz.*	
Unimpregnated uterus -	7 to 12 drams or a little more.	3 × 2 × 1 inches.

[These weights are chiefly taken from "Quain's Anatomy," 7th Ed.]

In the examination of the abdomen, the caution given under the heading of post-mortem stains or hypostases is especially necessary, namely, not to confuse those which are found in the most dependent parts with the effects of inflammation, either from natural causes, or from violence or poison.

As regards the stomach, it is also very necessary to remember that brandy and other stimulants given just before death, produce reddening of the mucous membrane. The stomach also undergoes digestion, or post-mortem solution, which appears to have attracted the attention of John Hunter, whose description is subjoined. He says: "There are very few dead bodies in which the stomach at its great end is not in some degree digested; and one who is acquainted with dissections can easily trace these gradations. To be sensible of this effect, nothing more is necessary than to compare the inner surface of the great end of the stomach with any other part of its inner surface, the sound portions will appear soft, spongy, and granulated, and without distinct blood-vessels, opaque and thick, while the others will appear smooth, thin, and more transparent, and the vessels will be seen ramifying in its substance; and upon squeezing the blood which they contain from the larger branches to the smaller, it will be found to pass out at the digested end of the vessels, and to appear like drops on the inner surface." (Hunter's "Animal Economy." Owen's edition, p. 119). If this digestion has been active, the stomach is often found perforated, and its contents escaped. Dr. Fenwick ("Morbid States of the Stomach and Duodenum," pp. 42-47) enters into this subject with some detail. In persons suddenly killed, as by lightning, whilst digestion is going on, in phthisis and other diseases with acid dyspepsia, and in persons suffering from cerebral disease, especially in warm weather, this post-mortem digestion will be most conspicuous.

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* Mr. Curling states the average weight of a healthy testicle to be 6 drams.

CHAPTER III.

Burying alive—Signs of death—Post-mortem temperatures—Post-mortem rigidity—Putrefaction—Adipocere—Order of signs of death.

There is a widely prevalent idea that premature interment, or in other words, "burying alive," is a common practice. Careful and unprejudiced inquiry leads to the conclusion that the frequency of this event has been enormously exaggerated. Yet it can scarcely be doubted that in hot countries, and sometimes even in temperate climes, persons who were not really dead have been buried; either from fear of contagion, during the prevalence of epidemics such as cholera, the plague, and other infectious diseases; or sometimes from worse motives, by interested relatives; at other times, particularly in hot countries, from the practice of burying on the day of, or the day after, death. The most important prizes at the disposal of the Paris Academy of Sciences in 1873 were those founded by the Marquis d'Ourches in reference to this very subject. The principal prize was a sum of 20,000 francs (£800) "for the discovery of a simple and popular mode of recognising the signs of real death, in a certain and indubitable manner, a method which may be put into practice by poor uneducated villagers." The other prize of 5,000 francs (£200) is to be given for "the discovery of a scientific method of recognising with certainty the signs of actual death." The great prize has not yet been awarded, and only a portion of the smaller one. In Great Britain interment is seldom so rapid as in foreign countries, and it is therefore seldom possible for so horrible a catastrophe as the burying of the quick with the dead, to occur. The question of the reality of death, which is far from being so simple as popular proverbs "dead as a door-nail," and the like would seem to imply, is however likely to be frequently referred to the medical practitioner, on one or more of the following occasions:—

1st. Those who have a great dread of being thus untimely disposed of, sometimes ordain by will, that before being "fastened down in their coffins," their bodies shall be examined by one or more competent medical men.

2nd. During cold weather, the signs of putrefaction are very slow in appearing; and certain modes of death are either so quick and painless, or so gradual and imperceptible in their progress, that the external appearance of the corpse differs little from that of the living person. Anxious relatives are therefore unwilling to lose their "beloved dead" out of their sight, unless skilled medical opinion declares the reality of death.

3rd. Although really included in the last heading, it may perhaps be worth noting separately, that certain accidents, such as railway collisions, producing shock or concussion, and compression; and mining accidents, or the effects of poisonous gases, often lead to medical men being consulted as to the reality of death, by the officials whose duty it is to provide for the safety of the wounded and injured.

4th. There are cases in which the singular phenomena commonly known as "a trance," have preceded death, or are suspected to exist.

5th. In some cases of succession to property of large amount, a medical witness may be asked to certify the reality of death. There may be other reasons not mentioned, but in any case the duty of the medical man, in the present state of our knowledge, is clearly *not to be satisfied with any one, or even two* of the ordinary *signs of death; but to refuse a certificate of death in all cases where a majority of the signs mentioned below are absent.* It is surely better to wait a few hours, or even days, than to incur so horrible a risk.

What then are the "Signs of Death?"

Briefly they are as follows:—

1st. *Entire cessation of the heart's action,* not for a few seconds only, but continuously. Mere absence of the pulse at the wrist, or even in other arteries, is not enough, as this may be found in cholera, abdominal collapse, and other kinds of shock, &c. Careful auscultation and palpation of the cardiac region, in a quiet room, can alone decide the absence of cardiac action. In doubtful cases it would be better to employ acupuncture of the left ventricle, and the stimulus of a galvanic shock to the cardiac region. It is well known that two sounds are caused by the heart's working, which have been compared to lūb-dŭp′p, lūb-dŭp′p, &c., but in cases of great weakness, only the second sound may be audible—a blowing sound (bruit) possibly replacing one or both of these in cases of valvular disease of the heart, of great anæmia (poverty of blood). Dr. G. W. Balfour has pointed out that fine needles with little cork or paper flags will often render cardiac movements visible where not previously so. It is doubtful, however, if this be available in cases such as we are describing. It should be remembered that there is a "pulse" wherever an artery is superficial enough to communicate its stroke to the exploring finger, as in the facial, the carotids of the neck, the brachial, radial, ulnar, femoral, popliteal, and anterior and posterior tibial arteries. *N.B.* Negative evidence from stethoscopic examination of the heart, great vessels, or lungs, can only be considered decisive when done some hours after the supposed death. There are many instances on record of recovery of infants and young children after the heart had apparently ceased to beat for at least a quarter of an hour. (*See* Drowning.) The phenomena of hybernation must not be forgotten. M. Bouchut states that the marmot or mountain rat during its torpid state has only some 8-10 beats of the heart per minute, whilst at other times the heart-beats are 80-90. He further states that in syncope the beats of the heart can almost always be heard by an experienced auscultator in a quiet room. Dr. Taylor recommends half an hour to be spent in auscultation. It would surely be better to auscultate at intervals of half an hour or more. The heart, and particularly its right auricle, "ultimum moriens," seems to have a life of its own, distinct from the great nervous centres, and continues to beat or contract even when cut into fragments, for some minutes after its removal from the body. The presumption of death when this last part of the body to die, no longer gives signs of life, must, therefore, be very strong. The case of Colonel

Townshend,* who could voluntarily suspend the action of his heart, should not be forgotten here.

IInd. *Entire cessation of respiration.* The act of breathing is so eminently a vital one, that any long suspension of this function (*See* Drowning) cannot but be fatal. Here again the stethoscope should be used, as careful auscultation is far more likely to detect the sounds caused by air, or air and mucus, or other fluids traversing the air tubes, than any other means. The use of a looking glass, to condense the moisture of the breath, and of a feather or other light body to indicate the movements of air, are popular, but not very satisfactory methods of ascertaining the continuance or otherwise of respiration. There is a peculiar mode of breathing known by the name of "Stokes'-Cheyne respiration," sometimes seen in cardiac and cerebral disease, rarely in fevers, in tubercular affections, and perhaps other maladies, which may deceive an incautious observer. The patient, in such cases, breathes at first so slightly as scarcely to seem to breathe at all, each succeeding inspiration is a little deeper until a maximum is reached, and then each breath that follows becomes shallower and shallower, till at last the patient may again appear not to breathe at all—then a feeble inspiration is taken, followed by another a little stronger, indicating the commencement of a new series like the former.

IIIrd. *Changes in and about the eye.* These consist of (1) an entire loss of sensibility to light. The pupil no longer contracts or dilates according to the amount of light thrown upon it. The best mode of testing this is known to ophthalmic surgeons as "oblique illumination." A bright light is placed on one side of the eye to be examined, and its rays brought to a focus by means of a double convex lens of about two inches focus—and the lens and light so disposed, that this focus falls upon, or nearly concides with, the pupillary aperture. When no change is produced, the iris remaining immovable, we may then usually conclude that life is extinct. Adhesions of long standing, belladonna or its alkaloid atropine and calabar bean, may, however, greatly affect the mobility of the iris, as is well known. Alcohol and some other poisons also produce similar effects. (2) There is an entire loss of sensibility to touch in the ocular conjunctivæ. This is, however, equally true of a period in epileptic fits, and in some cerebral injuries. (3) The conjunctiva covering the sclerotic soon begins to show a grey cloudy discoloration on its external portion, which soon becomes blackish. This is quickly followed by a similar stain on the inner side. M. Larcher, who first pointed this out, considers the phenomena to be due to cadaveric imbibition, and probably dependent upon putrefactive changes. "These two spots extend and approach each other, forming the segment of an ellipse." (4.) The cornea speedily loses its transparency, in other words, the eye has lost its lustre. This may, however, take place during life, as is repeatedly seen in cholera, and other diseases. (5.) The eye soon becomes sunken in its socket, and the globe itself becomes flaccid, so as to retain the dint or mark of any pressure made upon it. "Loss of tonicity, or minus tension," is, however, met with in some diseases of the eye. (6.) Supposing the cornea to be clear enough to allow of ophthalmoscopic examination, it is stated by M. Poncet that the yellowish red of the living fundus of the eye, is changed at the moment of death to a yellowish white, or paler hue. M. Bouchut states that beads of air or gas, in other words an interrupted column of blood, will be seen in the retinal veins resembling bubbles of air in the coloured fluid of a spirit thermometer, or the beaded appearance familiar to us in nerve tubes. (Pneumatosis of Retinal veins.) (7.) At the same time, the eyelids will have lost their elasticity—neither they nor the globe of the eye moving any longer. (8.) It is said that atropine and calabar bean no longer produce the dilatation and contraction which are their respective property. This is quite true of a body dead some days, but not always true of one dead only a few hours. (9.) Electric and mechanical stimuli equally fail to affect the eye of one dead some time.

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* See Dr. George Cheyne's "Treatise on Nervous Diseases," p. 307.

IVth. *Changes in the temperature of the body.* Gradual cooling or loss of heat is the most common change after death. In some diseases, however, the temperature of the body actually rises after death. This is particularly the case in yellow fever (as pointed out by Dr. Bennett Dowler), cholera, rheumatic fever, tetanus, and other injuries to the nervous system, small-pox, and some abdominal diseases, where a rise amounting to 9° F. (or 5° C.) has been noted after death. It is probable (as the blood is no longer cooled in the lungs) that there is a slight post-mortem elevation of internal temperature in all cases of death. Be this as it may, it is a familiar observation that within a few hours of death the body cools, more or less rapidly according to the external temperature, the amount of clothing, and other accidental circumstances. In the case of Gardner, a chimney-sweep, charged with the murder of his wife, and convicted in October, 1862, Mr. Sequeira, the medical man first called in, stated that she must have been dead at least four hours, as the body, lying on a wooden floor, covered only with a flannel petticoat and chemise, was quite cold and rigid. She had lost a large quantity of blood from a wound in the throat. This led to a number of observations on the temperature of dead bodies by Drs. Wilks and A. S. Taylor (*See* "Guy's Hospital Reports," Oct. 1863, p. 184, for the details), who give the following table :—

	First period, 2 to 3 hours.		Second period, 4 to 6 hours.		Third period, 6 to 8 hours.		Fourth period. 12 hours or more.	
Number of observations	76		49		29		35	
	F.	C.	F.	C.	F.	C.	F.	C.
Maximum temperature of the body.	94°	34·4°	86°	30°	80°	26·6°	79°	26·1°
Minimum temperature of the body. ...	60°	15·5°	62°	16·6°	60°	15·5°	56°	13·3°
Average temperature.	77°	25°	74°	23·3°	70°	21·1	69°	20·5°

These observations were made by simply placing the bulb of a thermometer on the skin of the abdomen. They found internal temperatures of 76° F., seventeen and eighteen hours after death, and of 85° F., ten hours after death. Very numerous observations have been made on the subject by Messrs. Durand and Linas. The result of their experiments seems to be that from eighteen to twenty-four hours are required for the body, under ordinary circumstances, to cool down to the temperature of the surrounding atmosphere.* In summer in hot days, a temperature of 25° C. (77° F.) is not uncommon, whilst an instance is recorded of a frozen woman restored to life by warmth, whose temperature was only 20° C. (68° F.). M. Laborde has stated that in five to eight hours the temperature of the deeper tissues in the dead body falls to 27° or 28° C. (=80·6 to 82·4° F.). But Dr. F. Niderkorn ("de la Rigidité cadavérique chez l'homme," Paris, 1872) shows that in six cases, taken indifferently six to eight hours after death, the rectal temperature averaged 32·6 C. (90·6° F.) and nine cases, in twelve to fourteen hours after death, gave a rectal temperature of 31·8 C. (89·2° F.). As these observations have not been published in English, we subjoin a summary of his observations—which are taken seriatim from 135 persons dying of various diseases. They differ from those of Drs. Wilks and Taylor by being taken in the axilla and at Paris :—

Temperature of body after death.	2 to 4 hours.		4 to 6 hours.		6 to 8 hours.		8 to 12 hours or more.	
Maxima	109·4° F.	43° C.	98·2° F.	36·8° C.	95·3° F.	35·2° C.	100·4° F.	37·8° C.
Minima	89·6° F.	32° C.	80·6° F.	27° C.	70·5° F.	21·4° C.	62·6° F.	17° C.
Average	96·9° F.	36·1° C.	90·2° F.	32·3° C.	81·7° F.	27·6° C.	77·9° F.	25·5° C.

The following seem the chief practical conclusions from these and other facts collected on this subject :—

1st. That even in winter the human body generally takes several hours, certainly not less than four, and sometimes twelve or even more (Nysten says "three days in cases of Asphyxia"), to cool down to the temperature of the surrounding air—especially if *internal* temperature be observed.

2nd. The *external temperature, the amount and kind of clothing*, and the *position of the body* all modify the rate of cooling. This cooling seems to depend upon (1) The cessation of heat production by vital or chemical processes; (2) Radiation; (3) Conduction and convection by cool air, cold ground, stones, wood, articles of bedding—and other substances upon which the body rests, or by which it is surrounded.

3rd. *Age* and *Sex* appear to modify this but little, if at all, *per se*, although the new-born fœtus probably cools more rapidly than older infants.

4th. The *mode of death* has far more to do with it. Large losses of blood are said, by Dr. B. Ward Richardson, to cause rapid cooling. This agrees with our own, and with common experience, but Dr. Taylor has shown that it is not invariably true. A man, aged forty-eight, died from losing about 4 lbs. of blood. Four hours after death the skin of his abdomen had a temperature of 84° F., eight hours after of 80° F., although the dead-house temperature was 38° F. only. The conditions were favourable to rapid cooling. It is, however, noteworthy, that he had met with an *accident*, necessitating ligature of his axillary artery.

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* We have been favoured by Dr. Letheby with some MS. notes of observations taken as far back as 1851, on the phenomena following death. The observations on temperature are of great interest. They include Axillary and Rectal temperatures, and the temperature of the room in which the bodies were. The temperatures of the earlier hours after death do not materially differ from those quoted. But some observations made on the bodies of adult males show that when the surrounding atmosphere was 55° to 57° Fahr. the axillary temperature was on an average 14°, and the rectal 18° Fahrenheit, *higher* than that of the air, so long after death as from 20 to 24 hours, the cooling being most rapid in the first few hours after death. Dr. Guy states that this cooling=about 1° F. per hour, which seems nearly correct.

Observations on temperature should be taken by a thermometer—and repeated at intervals of a few hours. It is the *progressive continuous cooling, not the absolute temperature, which indicates death.*

Vth. *Several minor phenomena, or so-called "tests" for death, have been observed, and may conveniently be grouped as follows* :—(1) If scarificators and cupping glasses be applied to any part, *e.g.*, the pit of the stomach, blood usually flows, but it will not do so after death, at all events not many hours. (M. Levasseur, Hotel Dieu.) (2) Bright steel needles inserted in any part of the skin, will be found free from rust even after some hours. (M. Laborde.) This appears greatly dependent on the amount of cooling and moisture, and is untrustworthy. (3) Wires attached to these needles no longer deflect a galvanometer. (See muscular irritability.) (4) It is stated that a burning match, hot sealing wax, cantharides-solutions, or blistering fluids no longer produce vesication. Here again there is a fallacy, as in young and healthy subjects, such effects do follow shortly after death, although not after the second or third day. (5) The finger and hands, especially in young subjects, are translucent during life, but become opaque after death. In other words, if a bright light be placed behind the hand of a living person, in a dark room, it shows a pinkish red, almost transparent appearance. (6) A string tied tightly round the finger of the supposed corpse will, if life be not extinct, shortly cause the finger to become bluish red. (7) As the arteries are well-known to be usually pale and empty of blood after death, Dr. Leon Davis proposes to cut down on the temporal or radial artery in doubtful cases, to ascertain the colour and contents. There are, however, exceptions to the above rule, especially when the arteries have become at all rigid. (8) It has been proposed to inject liquor ammoniæ subcutaneously. In the living body, or in one only just dead, a sort of port-wine congestion is immediately produced. In a body only just dead, a less degree of this might be visible; but in one dead some hours or days scarcely any change is produced.

VIth. *The limbs and joints of the body become stiff. In other words post-mortem rigidity sets in at a variable time after death.* This rigidity or stiffness is a phenomenon belonging to the voluntary muscles, and although much attention has been given to it, is a subject still involved in much obscurity. It does not seem certain as yet, that it is due to coagulation of the *mycsin*, or albuminous principle of muscular tissues. This body is obtained with difficulty in an uncoagulated state, from warm-blooded animals, and has an extraordinary tendency to coagulate at all temperatures above 32 F. (0° C.). The following facts on muscular rigidity appear well authenticated.*

(1) The coagulation of the muscle plasma is greatly accelerated by heat. At 40° C. (104° F.) it coagulates almost instantaneously. Cold water, and 15 per cent. solutions of sodium chloride coagulate it when

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* Most of these facts will be found in the excellent article by Dr. Michael Foster, in Klein, Sanderson, Foster and Brunton's "Handbook for the Physiological Laboratory." See also Dr. Hughes Bennett's "Text Book of Physiology," 1872.

it is dropped into them. In 10 per cent. solution of HCl it coagulates, but the clot is dissolved, and *syntonin* formed.

(2) Living muscles at rest have a double, or amphichromatic reaction on litmus papers, changing the colour of both blue and red. But the red is altered most, so that the muscular reaction may be described as *alkaline.*

(3) After *contraction* of a muscle in life, and during post-mortem rigidity, the reaction of the muscle is *acid* (reddens blue litmus paper). This is particularly evident in rigor-mortis.

(4) The acid rigid muscle, after death, again becomes soft, non-elastic, and alkaline, as soon as the post mortem rigidity has passed off. Lastly, (5) the *muscle in a state of rigor-mortis, has become opaque.* See No. (5), under the minor signs in last page.

Below 28° Fah. = – 11·° C. muscular fibres pass rapidly into some new molecular condition from which they do not return into active life by any known means of recovery (Dr. B. W. Richardson). Brown Séquard has shown that a current of arterial blood restores muscular contractility to rigid limbs.

The practical questions arising out of the phenomena of post-mortem rigidity are the following :—

(1) How soon after death does it come on?
(2) In what order are the various parts of the body affected?
(3) How soon does it pass off?
(4) By what circumstances is it modified?

On each and all of these questions there has been much discussion.

Old nurses, and "layers out" are always extremely anxious to close the eyelids with a penny piece, and to bind up the lower jaw the moment after death if they can, lest rigidity should supervene before they have time thus to compose the corpse. Our own observations have taught us that rigidity of the eyelids sometimes comes on in less than five minutes after death. Dr. Guy says, "Even before the heart has ceased to beat in some cases;" and Brown Séquard confirms this. Sommer says he has known it appear in ten minutes. From three to six hours is perhaps an average. Niderkorn, whose observations appear to have been made with great care, states that in more than two-thirds of his 135 cases post-mortem rigidity was complete in the third, fourth, fifth, or sixth hour; in only two out of 116 cases was it complete as early as two hours. But he states that in all the 135 cases, some one or more of the articulations were rigid within the first two hours after death. There seems no well-authenticated case in which the supervention of post-mortem rigidity has been delayed beyond the day of death, although there are numerous cases in which it passes off so quickly as to be unnoticed.

In what order are the various regions of the body affected? Nysten "Recherches de physiologie et de chimie pathologiques pour faire suite à celles de Bichat sur la vie et la mort" (A.D. 1811), says, "This stiffness always begins in the human subject with the trunk and neck, then attacks the thoracic limbs, and from them proceeds to the abdominal ones, so that the latter are still supple, when the former are already stiff; and it follows the same order in disappearing so that the legs are often quite stiff when the other parts of the body have regained their suppleness." He does not mention the jaw at all. *Sommer* ("De signis mortem hominis absolutem ante putredinis accessum indicantibus:" Copenhagen, 1833—a rare book, quoted by Orfila) says, "It begins in the neck and lower jaws, then attacks the upper extremities, lastly the pelvic limbs. It is rare for it to begin in the lower extremities, or to invade all four limbs at once. In 200 cases Sommer only found one in which it did not begin in the neck." *Larcher* (in a Memoir addressed to the Academy of Sciences, in the Archives de Médecine, 1862) founded on the examination of 600 bodies, states that, "The order of post-mortem rigidity is always the same, no matter what the kind of death, whether sudden or slow, natural or accidental. The muscles of the lower jaw stiffen first, then the abdominal limbs, then the neck muscles; lastly, more or less slowly, the thoracic limbs (arms). The muscles which are the first to stiffen, remain stiff the longest. It is also certain that the lower jaw, and the knee stiffen more slowly and thoroughly than the shoulder."

Casper states, that "It passes from above downwards, begins on the back of the neck and lower jaws, passes then into the facial muscles, the front of the neck, the chest, the upper extremities, and last of all the lower extremities. Usually it passes off in the same order, and once gone it never returns, and the body becomes as flexible as it formerly was."

Niderkorn (loc. cit., p. 91) thinks there is no such invariable law as these authors suppose. He says the hip and the knee go together, and the shoulder and elbow—in about half the cases the foot and wrist go with their larger joints. The *lower jaw* is usually first attacked, then the neck, then the lower extremities, but very often upper and lower extremities stiffen almost simultaneously.

In answer to the question, How soon does it pass off? it must be said that there are cases in which it passes off with extreme rapidity, even as soon as in one or two hours. In winter six or seven days are not uncommon. As long as three weeks has been noted in very cold weather. (*See* the next paragraph.)

The circumstances which modify post-mortem rigidity are (*a.*) the age of the subject, and the condition of the muscular system. Excluding fœtuses of immature growth, young subjects, &c., very old ones display the most complete rigidity. It is less marked in middle age, except in very muscular subjects. (*b.*) The mode of death. In very lingering diseases (such as phthisis) it often comes on very speedily, and disappears in an hour or two. In conditions of great exhaustion from fatigue (as at the end of a battle, or in hunted animals) the same thing occurs. In cholera it comes on early, and lasts late. In most cases of violent death, and of poisoning, it sets in late, and lasts long. Casper states that it is absent in narcotic poisoning. This is not however generally true. Habitual drunkards exhibit a long continuance of post-mortem rigidity. There can be no doubt that a low temperature of the surrounding air is favourable to the long persistence of this rigidity. On the other hand, Brown Séquard and others have shown that it may come on in a warm bath, that it is exceedingly well marked in hot countries, and that it often comes on when the internal temperature of the corpse is above the normal (*see* particularly Niderkorn, loc. cit. pp. 32 and 59). Paralysed limbs become rigid, but the muscles of limbs shattered by accident do not stiffen like others. Post-mortem rigidity has been stated (on the high authority of John Hunter), not to occur in death by lightning. Mr. Gulliver, and more lately Dr. B. Ward Richardson, have shown this to be erroneous, both by cases and experiments. The latter points out that animals dying with an increase of their normal or natural temperature speedily become very strongly rigid, and remain stiff a long time. This often happens in smallpox, acute rheumatism, tetanus, meningitis, abdominal diseases, pyæmia, and the like. Lastly, cold water is favourable to the long continuance of post-mortem rigidity. (*See* Drowning).

When a joint or articulation stiff from rigor-mortis, or post-mortem rigidity, is forcibly bent, the stiffness passes off, and does not return. This may distinguish death from certain cases of *supposed* trance, from cataleptic states, and from tetanic rigidity or the effect of poisons. The progressive loss of heat in post-mortem rigidity, and the application of other tests for the reality of death will also save the careful medical man from mistaking stiffness in the living body for the rigidity which comes on after death. (*See Catalepsy*, *Tetanus*, and *Hysteria*.)

VIIth. *Previous to the occurrence of post-mortem rigidity, the voluntary muscles have lost their irritability.* In other words, chemical, mechanical, and other irritants, such as interrupted and induced currents of electricity, no longer excite contractions of the muscles. Whilst referring to treatises on Physiology for details of the effects of various irritants on muscular fibres, the following facts appear to us of especial importance in a medico-legal point of view:

(1) Whilst healthy muscles are easily excited to contraction by interrupted currents of moderate force, (such as those from one of the ordinary "medical" machines in which the "keeper" is made to rotate between the poles of a magnet,) yet this contractility, even in life, may be in abeyance, or suspended, by the following agencies: (*a*) The effect of certain poisons, as in chronic lead-poisoning, Strychnine and its congeners, Nitrite of Amyl, &c. (*b*) By previous exhaustion, from long continued mechanical, electrical, and other stimuli. Hence it is undesirable in cases of suspended animation, to use galvanism or any form of electricity for prolonged periods of time. Even great fatigue, or repeated blows as in prize-fights, or prolonged struggles, will have the same effect. (*c*) Long continued cold suspends, without destroying the irritability of voluntary muscles. According to Dr. B. Ward Richardson (Croonian Lecture, 1873) from 38° to 28° F. is the most favourable degree of cold for mere suspension. (*d*) Increased heat, especially about 12° Fahrenheit (= 6·6° Centigrade), above the normal temperature of an animal, if long continued tends to bring about a permanent loss of irritability, or *rigor-mootis* in the muscles from coagulation of the myosine (Norris, Richardson, &c.). (*e*) A sudden sharp blow has been known to produce the same effect. (*f*) According to Nysten,* the order in which muscular irritability *ceases*, is

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* Onimus (Le Mouvement Médical, Feb., 1873), states that the first muscles to lose their excitability are the diaphragm and the tongue; then the facial muscles, of which the masseter is *last*. In two-and-half to three hours after death contractility is quite lost in all of them. In the limbs the extensor muscles go first—the flexors retain excitability about an hour longer. Five or six hours after death the trunk-muscles still answer to faradisation—the abdominal muscles sometimes even later than this.

the following: first in the left ventricle of the heart, then in the intestines and stomach, the urinary bladder, right ventricle of heart, œsophagus, iris, then in the voluntary muscles of the trunk, lower and upper extremities, lastly in the left and right auricle of the heart. (*g*) Certain diseases of the Brain and Spinal Cord (Paralyses, especially Paraplegia, Pseudo-hypertrophic Paralysis of Duchenne, &c.) show suspension or entire loss of this irritability. (*h*) During contraction of a muscle *heat* is produced, hence as a test, it has been proposed to insert a delicate thermometer (registering at least 10ths of a degree centigrade), into the muscle to be tested, whilst an electric current is passed through it, or still better, through its nerve. (*i*) Sound is also produced, when muscles contract forcibly. This susurrus might therefore be listened for with the stethoscope, whilst making the experiment to induce contraction. (To imitate this, listen over Biceps whilst contracting, or insert tip of little finger into ear, and contract muscles of ball of thumbs quickly. Dr. Wollaston.) (*j*) After death, notably in Yellow Fever, Cholera, and some other diseases, muscular movements, and muscular irritability in a marked degree, may persist for several hours after death, in other words, after respiration and circulation have ceased. (*See* Dr. Bennet Dowler's Experimental Researches on Post-mortem Contractility, New York, 1846.) Of this we were ourselves witnesses in the Cholera Epidemic of 1866.* (*k*) It is a disputed point whether the blood has any appreciable influence upon muscular irritability after death. It is however known that ligature of a large artery in animals, suspends or greatly diminishes this irritability, as do large losses of blood, whilst artificial circulation, especially of warm fluids restores it. (*l*) Lastly, certain curious so-called psychical states, such as trance, hysteria, shock, &c., suspend or greatly impair muscular contractability.

VIIIth. *Putrefaction, although usually a late, is perhaps the most certain sign of death we possess.* Yet it scarcely deserves the name of an *infallible sign*, given it by Dr. Guy, for the following reasons: (1) In a living body, a portion may die, as in the case of gangrene of limbs, or on the face, trunk, &c., after severe local injuries, or in certain feeble states of health. (2) The spontaneous changes of colour undergone by extravasated blood, what is popularly known as "a bruise," simulate the colouration due to putrefaction. It is pretty obvious too that such an appearance might be artificially produced by pigments. (3) The odour of decomposition so far from being exclusively a post-mortem phenomenon, is met with in certain diseases as gangrene of the lungs, &c., ulcers of the lower extremities, caries of bones (Ozœna), and the like. It must however, be admitted that general and advanced decomposition of the tissues is one of the safest signs of death. The phenomena presented by dead bodies undergoing putrefaction may be classed as follows:—

(A) Appearances due to extravasation and imbibition of fluids. (B) Those due to putrefaction itself, and the evolution of gases.

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* When such movements are rapidly succeeded by post-mortem rigidity, the limbs of a corpse, or the body itself, may sometimes be found in very singular positions, and these attitudes may even give rise to the supposition of murder: this is most likely to occur in cases of sudden death, from apoplexy, &c. See Taylor's P. and P. of M. J., Vol. I., p. 70–73.

(C) Those due to saponification, on the formation of *adipocere.* (D) Those due to mummification, or slow drying of the tissues.

A. Appearances due to extravasation of and imbibition of fluids. Post-mortem stains or hypostases. Very soon after death (8—12 hours, *Casper*) the dependent or lowest parts of the body (no matter what the position) acquire an appearance which closely simulates the effects of bruises or contusions. The blood *within* the body, after death, coagulates, just as blood withdrawn from the living body does, though more slowly. In acute inflammations, where the amount of fibrin is much increased, this coagulation sometimes precedes the actual moment of death, and is in fact one of the modes of death. In diseases such as those fevers which diminish the quantity of fibrin or reduce it to almost nothing, as *e.g.* phthisis, the blood may scarcely coagulate at all. Sir James Paget has drawn attention to the subject of "Coagulation of the Blood after Death," in a paper with this title in the "London Medical Gazette," vol. xxvii., p. 613, &c. He shows that the position of the red-blood corpuscles, in other words, of the most deeply coloured portion of the clot, may often determine the position of the body at the time of death. It is generally said that the seat of the discolourations after death (cadaveric lividity) differs from that of the discolouration produced when the man was alive; the rete mucosum and vascular membrane exterior to (above) the true skin, being the parts affected by post-mortem changes, the true skin being found injected and ecchymosed in bruises inflicted during life, and from the effects of poisons and struggles. Dr. Guy has shown that this is by no means always true (Manual, p. 238). No blood flows from an incision into post-mortem stains, or at most only a few bloody points can be made out in most cases. In cases of dropsy, however, a blood-stained serum might exude. These, port-mortem stains or hypostases (ὑπο ἱστημι) are divided into internal and external. The latter are to be looked for at the back of the head, neck, and trunk, the nates, back of arms and thighs, calves, &c., in ordinary cases; but they may also be found on the face, ears and sides, and as before stated, on the lowest or most dependent parts of the body, whatever its position may have been. If the body be turned over whilst still warm, the original stains more or less disappear, and fresh ones may form. The colour varies from livid or coppery red to reddish blue, and the outlines are very irregular, as is the size of the spots or stains. Some medical jurists call these post-mortem stains *sugillation*, an ambiguous term (*see* Contusions). Those resembling stripes are called *vibices.* It is important for you to know that such marks closely simulating the effects of flogging, may be produced by the pressure of clothes, or of the surface on which the body is lying (*see* also on the marks of ligatures under *Suffocation*). Occasionally post-mortem ecchymoses, particularly in death by lightning, assume an arborescent or tree-like form, which appears to be due to the distension of cutaneous capillaries and small veins. The larger marks do not always correspond to the cutaneous veins, &c., described in books, but it must be remembered that great irregularities are met with in the cutaneous veins.

Internal hypostases, or blood-stains, occur chiefly in the following situations:—(1) In the veins of the pia-mater of the posterior hemisphere, in the ordinary position of the head after death. (2) In the posterior part of the lungs. This appears to be true of *all* bodies, especially in cases of old or feeble persons. About one-fourth of the lungs is thus marked. (3) On the intestines. This may be mistaken by the incautious for peritonitis. To guard yourselves from this, pull the convolutions of the bowels forwards, and you will see " breaks" in the redness. On the posterior or dependent portions of the *interior* of the stomach and small intestines a similar discolouration may be met with, due simply to the same hypostatic conditions. (4) In the posterior part of the kidneys. (5) In the posterior part of the spinal cord, particularly of its pia-mater. You should familiarise yourselves with the appearances presented in the post-mortem room, both on the exterior and interior of the body. This will be your best safeguard against those ridiculous mistakes which are constantly made by persons ignorant of these matters. Were they only ridiculous, but little harm would be done; but, unfortunately, there is a serious side, and innocent persons may be condemned by mistakes originating in ignorance. It must be confessed that much remains yet to be learnt of the true nature of these post-mortem changes. It is quite clear that besides coagulation of the blood, there is a lake-like solution of the colouring-matter in many cases, probably due to ammoniacal gas, and that the subsequent changes of colour are due to varying degrees of oxidation, and to the separation of iron from the colouring-matter. Similar changes occur in old apoplectic clots.

Bile-stains.—Soon after death changes take place in bile, so that its colouring-matter oozes through the gall-bladder, and other parts which contain it. In this way the contiguous parts of the stomach and intestines may be stained of a yellowish or greenish colour. Do not mistake this for the effect of corrosive poisons.

B. Changes produced by putrefaction and the evolution of gases.—These become evident to sight, smell, and chemical tests. One of the earliest signs of putrefaction is a greenish or greenish-purple, or yellowish-green discolouration of the skin of the abdomen. This next extends itself to the genitals, and then to other parts of the body. The discolouration of the eye has already been noticed. Next, gases of various kinds are generated in more or less abundance, giving the body a bloated appearance, and especially distending the abdomen. In some cases the gas is highly inflammable. The chief gases which have been recognised by chemists as evolved from decomposing bodies are: *Carbonic acid* (known by reaction with lime or baryta water, and reddening litmus paper fugitively); *Carbonic oxide* (burns with pale blue flame); *Ammonia* (by pungent odour, bluing red litmus, and fuming with hydrochloric acid); *Hydrogen sulphide* (blackens lead-paper); *Carburetted hydrogen* (burns like coal-gas, and produces water and $C\,O_2$ in combustion); *Phosphoretted hydrogen* (recognised by inflammability, and by paper soaked in nitrate of silver, which has been kept in the dark, and moistened just before use); *Nitrogen*, known by its negative properties, and *Carbonate of ammonia.* If the sulphuretted hydrogen and ammonia are combined, paper moistened with nitro-prusside of sodium acquires a crimson tint by exposure to the gas. (Dr. A. S. Taylor.) Other gases may be generated, either from the tissues, or from the food and fæces in the stomach and intestines. These gases tinge both the exterior and interior of the viscera in a remarkable manner, often resembling the effects of poison. Reddish-brown, deep-livid purples, slate colour, and green or greenish-yellow, or even black streaks or lines, may be found. The colour of the blood in the veins or heart may also be greatly changed by these spontaneous decompositions. *It is thus* *extremely important to note the time after death, and the amount of putrefactive changes present.*

The force of the gas generated has been sufficient, in some cases, to empty the heart and great vessels—even, it is said, to expel the fœtus from the uterus (!) and to burst the coffins, even when made of lead, in which such bodies have been enclosed. There is a popular idea prevalent, that it is *common* for bodies to burst; but this is the reverse of truth. With a view to economise space, we have constructed the following table.

Tabular view of the circumstances affecting putrefaction.

Things which favour putrefaction.	*Things which retard it.*
Temperatures between 70° and 100° F. (21.1° and 37.7° C.), therefore summer weather and warm rooms.	Temperature of 32° F. (0° C.), and below this (cold weather and cold rooms).
Moisture—therefore brain and eye soon putrefy, so do dropsical subjects.	Temperature *above* 212 F. (100 C.). Hemorrhages, if very profuse.
Low swampy ground.	Complete, or nearly complete immersion in water retards decomposition (*see* Drowning). A *deep grave.*
Free access of air.	The body being protected by clothing, or other coverings.
A shallow grave.	Burial, especially in dry sand or earth, and burial very soon after death.
Absence of clothing.	Dry, elevated ground.
Previous injuries and diseases, as bruises, wounds, inflammations.	Some poisons, as arsenic, alcohol, chloroform, strychnine (?), phosphorus. (Casper.)
Sudden death.	Certain gases. Nitrogen, the residuum of air enclosed in air-tight coffins.
Acute diseases.	Leanness.
Childhood (*see* Infanticide), and according to Orfila, the *female* sex—especially after childbirth. (Casper.)	Old age, unless corpulence, or other special reason, as dropsy.
Corpulence.	Lime, as opposed to the popular views.
Animal poisons, prussic acid (?), some of the poisonous gases. Oxygen.	

For an account of the changes undergone by bodies more or less immersed in water, it seems to us far more convenient to the student to refer to the articles on *Drowning.* See, also, *Adipocere,* in the next section. For the effects of various modes of death, as poisons, on putrefaction, reference must also be made to the articles on the various poisons.

You may probably be asked, "*How soon after death can putrefaction occur?*" Your answer must be that, under favourable conditions, it may supervene within a very few hours after death—certainly, within six or eight hours—even to the production of vesications. Dr. Taylor states that it does not, and cannot, begin until post-mortem rigidity has passed off. One of the authors, however, lately saw a case with Dr. Herbert Davies, in rather cold weather, in which the corpse of a young girl was still rigid a week after death, but putrefaction had commenced, and had even attacked the face. The answer to another probable question, "*How long can it be retarded?*" cannot be so definite. Under *Mummification, Drowning,* &c., you will gain some idea how you ought to answer such a question. A remarkable instance of the preservative power of cold is given by Adolph Erman, who states that the body of

Prince Menchikof, a favourite of Peter the Great, exhumed, after ninety-two years' burial in frozen soil, at Beresov (in Siberia), had undergone hardly any change. The "Quarterly Journal of Science," vol. viii. p. 95, gives an account of the discovery, in a remarkable state of preservation, of the body of an extinct species of elephant (*E. primigenius*) in a mass of ice in Siberia, in the year 1805.

Besides the colour-changes, and development of gases in putrefaction, the following alterations in the dead body are caused by it. The diaphragm is forced up by the distended bowels; the blood is forced towards the head and neck; the face swells; the eyes, which had been sunken, now become horribly prominent, and collapse at a later period; mucus, bloody froth, or the contents of the stomach and lungs, come from the mouth. Rarely, the contents of the bowels escape. Blood, or rather blood-like fluid, exudes from ruptured vessels, or from old wounds. (This was thought, in bygone days, to be due to the presence of the murderer!) Loose tissues (eyelids, scrotum, penis, the great labia) are distended. Bullæ, or vesications, form; and the hair, nails, and scarf-skin easily become detached. *The breath and portions of the body have been luminous in the dark in some cases;* generally in advanced stages of consumption, or wasting disease.

Although the occurrence of putrefaction is very variable as to time, the general order for the time and succession of its various steps can scarcely be better given than in Dr. Letheby's words ("Lancet," Vol. i., 1846, p. 412):—

"In about eight or ten hours after death, the surface of the body, especially over the chest and on the inside of the arms and thighs, puts on a marbled appearance, due to a turgescence of the superficial veins. In about sixteen hours the dependent parts become livid or reddish-purple, and, after the lapse of twenty-four hours, this lividity is generally very marked, and the marbling on the chest and arms begins to acquire a purplish tint. About the second day it assumes a brownish hue, and at this time the abdomen and groins show more evident marks of the putrefactive process by acquiring a green colour. From this period it advances with more or less rapidity, according to attendant circumstances. In five or six days the entire surface is ordinarily very green, and the venous marbling still strongly marked. About this time, in warm weather, the epidermis begins to loosen, and the fluids acquire great liquidity, and gravitate to the dependent parts, through which they readily escape. Beyond this, the track of decomposition can scarcely be followed with any certainty."

"*In what order does putrefaction advance in internal organs?*" In other words, What parts of the body putrefy first, and which resist it longest? As an aid to the memory, it may be said that the *windpipe* and *brain* are first attacked, and the *heart, lungs*, and *uterus* last. The other facts are tabulated from Casper; but there is a pretty general agreement on this subject amongst practical men.

Table of *order*, in which internal organs are attacked by putrefaction:—

1. Larynx and trachea; 2. Brain of infants and young children; 3. Stomach; 4. Intestines; 5. Spleen (to this there are many exceptions occurring at an earlier period); 6. Liver (gall-bladder collapses, but

does not putrefy so soon); 7. Brain of adults; 8. Lungs and heart; 9. Kidneys; 10. Urinary bladder; 11. Œsophagus or gullet; 12. Pancreas; 13. Diaphragm; 14. Large blood-vessels; 15. Last of all the Uterus. (*See* under determination of *Sex.*)

C. Appearances due to saponification, or the formation of *Adipocere.* Under certain circumstances, particularly in bodies long immersed in water, in very fat bodies, particularly of young persons, and in bodies buried one on top of another, at a considerable depth, in a moist soil, a curious soapy, unctuous substance, named Adipocere, from *adeps*, lard, and *cera*, wax, is formed principally out of the fatty tissues. Although it is said to have been known to the ancients, and mentioned by Lord Bacon, this substance attracted little attention till the publication of Fourcroy's "Memoir," read in 1789 to the Royal Academy of Sciences of Paris. He found in the removal of large numbers of bodies from the Cimetière des Innocens in Paris, that the bodies presented three different states:—(1) The most ancient were simply portions of bones, irregularly dispersed in the soil, which had been frequently disturbed; (2) A second state exhibited the skin, muscles, tendons, and aponeuroses, in bodies which had been insulated, dry, brittle, hard, more or less grey, and like what are called "Mummies" (*see* next section); (3) The most singular state was observed in the "fosses communes," where large numbers had been interred in deep pits, one above the other. On opening one of these, which had been quite closed for fifteen years, he found the coffins fairly preserved: the linen which had covered them was slightly adherent to the flattened bodies, and with the form of the different regions exhibited; on removing the linen, nothing but irregular masses of a soft ductile matter, of a grey-white colour, resembling common white cheese. "It was sometimes found nearly white, at others yellowish brown; sometimes brittle and dry, always more or less unctuous or soapy." Since the publication of this Memoir, many researches have been made into the formation of this singular substance, which is by no means invariably of the same composition. Thus some samples melt at less than 200° Fahrenheit; some, examined by Dr. Taylor, required a higher temperature. Most specimens appear to be an ammoniacal soap, and are soluble in hot alcohol, making a lather with water, whilst others contain lime as a base. Whether lime or ammonia, the base is combined with oleic, stearic, and perhaps palmitic acid. As all the tissues contain more or less fat, almost every part of the body may be gradually converted into Adipocere—even the bones to a great extent—but the skin, breasts, and fat of various organs are first so converted; more slowly muscles, solid viscera, and the harder tissues. (For further accounts of this substance, *see* Dr. Taylor (loc. cit. p. 109); Ure's "Dictionary of the Arts," and *art.* Adipocere; Hooper's "Med. Dictionary," *art.* Adipocere; Wetherell, in "Archiv der Pharmacie," 1857, Feb., p. 203; Guy's "Forensic Medicine," p. 245; "Devergie, Annales d'Hygiène," vol. ii., &c. &c.) It appears certain that under favourable circumstances, as in running water, a body can be partially converted into Adipocere in from four to five or six weeks. (*See* Devergie, loc. cit.; also Dr. Giles's "Experiments upon Meat.") Dr. Taylor states that a female interred in a common grave, after fourteen months, was found partially converted into this substance, chiefly the lower part of her body. The *period* required by this change is therefore much less than was stated by the grave-diggers to Fourcroy.

This has already been the subject of inquiry at a trial. (For full particulars of which, *see* Beck's "Medical Jurisprudence," 5th edit., p. 599.) The question was tried at the Lent assizes, at Warwick, in the year 1805. An insolvent gentleman, named Meecham, left his house Nov. 3rd, as was supposed from his words and manner, to destroy himself. Five weeks and four days after (Dec. 12), his body was found floating down a river, three miles from his home. Besides appearances of putrefaction in the face and scalp, the lower part of the abdomen and the glutei muscles were found converted into Adipocere. A commission of bankruptcy was taken out against him a *few days after he left home.* The medico-legal question was, "Is it probable he drowned himself on the day he left home?" In which case the bankruptcy would be annulled. Dr. Gibbes, of Bath, gave evidence that Adipocere required at least a month, perhaps five or six weeks, to be found in any quantity, even in running water. The jury decided on this, that he had drowned himself when the commission was taken out. (This formed the subject of one of the M. B. questions at Cambridge in 1872.)

D. Appearances due to mummification. Probably most of you are familiar with the appearances of an Egyptian mummy. Most of our medical museums contain some specimens of bodies, or portions of such, in this condition. Our dissecting-rooms also give occasional samples from the bodies of old or bloodless persons. Similar changes occur in dry or senile gangrene, and in bodies embalmed. It is said that Shakspeare's expression ("Hamlet," Act. V. Scene I.), "A tanner will last you nine year!" is literally true. Bodies exposed to a drying wind, as in an open vault at Charlottenberg, near Berlin, appear to be preserved in a very wonderful manner. (Casper, vol. i.; Dr. Balfour's Trans., p. 43.) Embalming enables even the features to be identified after the lapse of more than a century. Thus the body of King Charles I., after 165 years, was easily recognized. (*See* Sir Henry Halford's "Account of the Opening of the Tomb of Charles I.," in his Essays and Orations. A reduced copy of the engraving of the face, &c., will be found in Guy's "Forensic Medicine," p. 10.)

The aboriginal inhabitants of the Canary Islands preserved the bodies of their deceased friends, which have been found in great numbers in the Catacombs in Palma, Ferro, Teneriffe, &c.: the natives called them Χαχος. The entrails appear to have been removed, the bodies dried in air, with the addition of spices, and some sort of varnish? Humboldt found similar mummies in Mexico and Peru. In the celebrated Monastery of St. Bernard, the bodies of travellers found dead in the snow are deposited in a chapel, with open grated windows; they are in a sitting position, leaning each on another's breast. Here cold seems to have preserved them, and given time for drying. The following are also instances of long preservation by embalming:—King Edward I., buried in 1307, was found entire in 1770 (463 years); Canute died in 1036, and his body was found very fresh in 1776 (740 years); the bodies of William the Conqueror, and his Queen Matilda, were found entire at Caen in the sixteenth century. The vaults at Dublin, the Cemetery of the Cordeliers at Toulouse, the Capuchin vaults, near Palermo, as well as the Catacombs in the East, and at Rome and Paris, present many specimens of natural mummies. Though not much is known of the time required for such natural desiccation, it appears pretty certain that bodies of a rather dry nature (*i.e.* not containing much blood or fat, and abounding in fibrous tissue), exposed to a dry air, and protected from moisture, are likely to be preserved longest.

As regards *hair, teeth, skin and bones*, there seems scarcely any limit to the time they may be preserved under favourable conditions.

We have ourselves examined portions of skin, the history of which was that they belonged to Danes, who had been flayed (probably alive) for piracy, more than 1000 years ago. Analogous facts are presented by specimens from the vegetable kingdom in our museums and horti sicci.

Order in which the Signs of Death succeed each other.

The rapidity of decomposition in some cases, and the length of time during which it is retarded in others, renders it very unsafe to give any general formula which shall settle the time a body has been dead. Your opinion must be founded upon the condition of all the organs—the mode of death, and the surroundings—including in the latter term the season of the year, the amount of heat and moisture, and the quantity of clothing, depth of grave, &c. But Casper's rules will be found correct in the majority of cases. With slight alteration, these are as follows (loc. cit. vol. i. pp. 15—40):—

I. Signs of death present in bodies dead from ten to twelve hours at longest.

1. Complete cessation of Respiration and Circulation—no evidence of either, even by auscultation.
2. The eye has lost its lustre, the pupil is immovable, and the globe has lost its normal tension.
3. No stimulus has any power of producing reaction.

[In previously healthy subjects who have met with a violent or sudden death, Galvanism (interrupted currents or shocks from any electric machine), may, however, produce movements, as in Galvani's well-known experiments for some hours after death.]

4. The body is ashy white. [Except in jaundice, or yellow colourations from poisons, and in persons with very florid complexions. Tattoo-marks, the edges of ulcers, bruises, and wounds inflicted during life, and extravasations, as in Purpura, must be excepted also.]
5. Most bodies are quite cold in from eight to twelve hours (*vide* antea).
6. There is a state of general relaxation and flaccidity (unless rigor-mortis be present, and sometimes even then), with flattening of the nates, calves, &c., when subjected to the pressure of their own weight, and this is strikingly shown in the globe of the eye.
7. Dependent or posterior portions of the body begin to exhibit a bruise-like condition, known as post-mortem staining, or hypostases—internal and external.

II. Signs of death present in bodies dead from two to three days. In addition to all, or nearly all the preceding, especially the post-mortem stains, we get

8. Coagulation of the blood (*see* before), and
9. Rigor-mortis is either present, or has passed off. (See before, p. 18, for rules and exceptions.)

As regards *frozen* bodies, the rigidity due to frost is known by its affecting all parts of the body, and completely fixing the articulations.

III. Signs of death in bodies dead more than three days.

10. Except in very rare cases, there will now be signs of *putrefaction.* The exceptions will be in very cold weather, or bodies preserved in ice, or some modes of death (as alcohol poisoning), or when some method of hindering decomposition, has been employed; or at later periods, when mummification or saponification [formation of Adipocere], of which we have just spoken, has modified this process.* (11.) The *temperature* will now be that of the surrounding medium, or but little above it. (12.) And the muscles will no longer respond to the strongest galvanic current or electric shock.

Cautions as to Putrefaction.

It is generally admitted that the earlier stages of this process are the most dangerous as regards infection from what are commonly called "post-mortem or dissection-wounds." Some of the later stages may, however, be equally dangerous, or even more so, unless precautions are taken to insure the dilution of the poisonous gases with a large bulk of air, and disinfection by chemical means. These matters are, however, not so much within the province of legal medicine as the following:—

1st. Casper states, very properly, that bodies green from putridity, blown up with gases, and excoriated, at the expiration of one month, or from three to five months after death (this stage of putrefaction lasting a long time in some cases), *cæt. par.*, cannot with any certainty be distinguished from each other, as regards either recognizing the features, or stating which died first, or how long death has taken place.

But, 2ndly. We should hardly ever refuse to perform a post-mortem examination merely on account of putridity, since in the most rotten corpses we can generally determine the sex and age (from the bones or hair, or discovery of a uterus), and very often the mode of death, as for example, in apoplexy, aneurism, and many forms of poisoning, notably arsenical, strychnine, and sometimes the existence of pregnancy, from finding fœtal bones, &c., in the interior of a woman's body; or some article, as a false tooth, or ring, or truss, or the loss of a limb, or an ununited or other fracture which may lead to identification, as an ununited fracture did in the case of Doctor Livingstone.

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* Casper states that his experience leads him to conclude that the following proportion is not far from the exact truth:—"*At a tolerably similar average temperature, the degree of putrefaction present in a body after lying in the open air for one week* (*or month*), *corresponds to that found in a body after lying in the water two weeks* (*or months*), *or after lying in the earth in the usual manner for eight weeks* (*or months*). The latter refers to the prompt burial more common abroad than in England, but after the first week this proportion will be found pretty exact.

CHAPTER IV.

ON POISONS AND POISONING.

Definition of a poison—Action of poisons—Circumstances modifying their action—Circumstances leading to the suspicion of poison having been administered—Symptoms of (1) Corrosive, (2) Irritant, (3) Narcotic and narcotico-acrid poisons—Treatment of poisoning cases—Conclusions to be drawn from analyses—How far poisons are natural constituents of the body—Hints for a post-mortem—Post-mortem appearances in different forms of poisoning—Diseases that simulate poisoning—Cases of supposed poisoning and malingering—Classification of poisons.

The reply to the question, "*What is a poison?*" seems simple enough. In common language, we say, "It is a substance capable of destroying life promptly when taken in small quantity." But this popular notion of a poison is not sufficiently exact for the medical jurist; for, as the law does not define a poison, its strict definition by the medical witness often becomes a matter of paramount importance.

We are indebted to Dr. Letheby for the following definition of a poison:—"Anything which otherwise than by the agency of heat or electricity is capable of destroying life, either by chemical action on the tissues of the living body or by physiological action from absorption into the living system."

It will be remarked that in this definition no reference is made to the quantity of the drug necessary to destroy life. Nor would it be accurate to do so. Oxalic acid is a poison, and an active one; but usually at least half an ounce is necessary to cause death. Half an ounce can scarcely be called a small quantity. Similarly, too, if quantity was to be regarded as an essential element in the definition of a poison, the salts of several of the metals would necessarily be excluded from the category of poisons.

Again, a poison may be administered in several ways other than by the mouth. It may be hypodermically injected or applied to the rectum, vagina, ear, or nostril, or to the lungs, or to the skin, abraded or unbroken. Our definition, therefore, must provide for any mode of administration. The Act uses the words "*administered to*" or "*taken by*" the person killed, the words "apply or administer to" being added in a later Act, to provide for the administration of "chloroform, laudanum, or other stupefying or overpowering drug, matter, or thing." In all this the want of accuracy of definition is manifest. For instance, it might be questioned whether the external application of a poison to an abraded surface would be comprehended in the phrase "administer to," although such a case we should suppose might fairly be regarded as the application of "an overpowering drug."

Again, the action of a poison in destroying life must be either *chemical* or *physiological*, and not merely mechanical. Pins, needles, sponge, &c., are not poisons, although they may destroy life given internally, their action being strictly mechanical, and not chemical or physiological.

To sustain a capital charge, it is necessary to prove (1 Vict. cap. 85, sec. 2) that the substance administered is "a poison or other destructive thing" "given" "with intent to commit murder." What is the difference, we must ask, between a "poison" and "a destructive thing"? A poison must be a destructive thing, but a destructive thing is not necessarily a poison. A poison, as we have said, destroys life, either by a chemical or physiological action, whilst a destructive thing may act purely mechanically. This term, therefore, will include pins, needles, and so forth.

In most indictments the term "*deadly* poison" is used. Mr. Justice Erle ("Law Times," April 12, 1845) has wisely decided that this and such like terms are mere "legal surplusage," although their objectionable character is constantly to be noted by the frequent legal quibbles they involve. Whether the administration of a poison is followed by death, or not, it is a capital felony, provided it be proved that the poison was given "with intent to commit murder." Failing, however, to prove the intent to commit murder (which cases formerly escaped justice) an Act was passed (23 Vict. cap. 8, March 23, 1860), providing for those cases where poisons such as phosphorus, cantharides, tartar emetic, &c., were administered for the mere purpose of annoyance, or even for worse motives. It provides—

1. That the administration of a poison, or other destructive or noxious thing, with intent to endanger life or inflict grievous bodily harm, is *felony*, the sentence being penal servitude for not more than ten nor less than three years, or imprisonment for not more than three years with or without hard labour.
2. That the administration of a poison, or other destructive thing, with intent to injure, grieve, or annoy a person, is a *misdemeanour*, the sentence being imprisonment for not exceeding three years with or without hard labour.
3. That a jury failing to convict a prisoner for felony, is at liberty to return him guilty of misdemeanour.

Further, *the attempt* to administer a poison, although it may be unsuccessful, is regarded as a felony punishable by transportation.

A curious question has been raised (Reg. *v.* Cluderay, Jan. 19, 1849), whether the administration of a berry that was poisonous, enclosed in a non-poisonous husk, and which, consequently, allowed the poisonous body to pass through the system without injury to the person to whom it was administered, was a criminal act. It was decided that this was the administration of a poison with intent to murder.

It has been decided upon several occasions that, the intent being proved, although the amount of poison administered might be insufficient to cause death, the crime of attempting to administer poison is complete.

It is difficult to define the exact boundary between a medicine and a poison. A medicine in a large dose may be a poison, and so also may any active drug, although it be only administered in medicinal doses, if such doses are too frequently repeated.

In what way do Poisons act?

The action of poisons is either—

1. *Local, i.e.* when the action is confined to the part to which the poison is applied; or

2. *Remote, i.e.* when the action extends to distant organs.

I. Local.—Strong acids, caustic alkalies, or corrosive salts applied either externally or internally produce *corrosion* at the spot where they are applied. Similarly, arsenic, tartar emetic, cantharides, and other irritants, produce *inflammation* and its results. The local action of a poison on *nerves* is illustrated by the anæsthetic action of chloroform or veratria; the local action on *muscle* by the effects of belladonna and Calabar bean on the iris. The local action, therefore, of some poisons, it will be seen, is entirely *chemical, e.g.*, nitric acid, the mineral salts, and all such bodies as coagulate albumen; whilst of others it is entirely *physiological*, as *e.g.*, aconite, belladonna, opium, &c.

II. Remote.—Death is very rarely brought about merely by the local action of a poison. In some few cases, as with mineral acids or caustic alkalies, such a thing may happen, but far more frequently the true death action is a remote one: we mean by that an injury set up in some other organ to which the poison has not been directly applied. The effects of arsenic in producing inflammation of the mucous membranes generally, and the effects of strychnia on the nervous system, are illustrations in point.

Further, the remote action of a poison is seldom a *general* action. All poisons, moreover, do not act on the same organs, nor do they destroy life in the same way. Poisons possess a certain power of selection, acting upon tissues or upon organs peculiar to themselves.

By some the *heart* is specially affected, as, *e.g.*, by digitalis, tobacco, oxalic acid, baryta, and strontia; and by lead, zinc, and copper salts. Cardiac paralysis may in this way be produced by the poisoned blood finding its way into the coronary arteries.

The *organs of respiration* are affected by others, as, *e.g.*, by hydrocyanic acid, euphorbium, tobacco, &c. With these poisons suffocation is produced by an arrest of the capillary circulation. Antimony, likewise, although it possesses a depressing influence on the system generally, has a special action on the lungs.

The *brain* is affected by others, as, *e.g.*, by opium. Morphia, alcohol, and nitro-benzol may generally be found in the brain after poisoning with these drugs; the fatal result being probably due to an indirect action on the respiration.

The *spinal cord*, again, is affected by strychnia. This effect is independent of any action on the brain (Emmert), inasmuch as it happens when the connection between them is severed.

We find as a matter of fact that poisons generally have a decided preference for locating themselves in the liver, and hence the importance in all medico-legal investigations of specially preserving and examining this viscus.

Although we may in this manner systematize the selective action of poisons, it is more common to find very considerable complications, from more organs than one being attacked; the extent of action, and the organs affected being largely influenced by the quantity of the poison taken. As an example of this we often find the stomach, the heart, the brain, and the spinal cord all more or less affected by a large dose of oxalic acid.

This remote selective action of poisons is a subject demanding close attention, inasmuch as symptoms of the greatest value may be noticed enabling us to distinguish the very poison that has been taken, or at any rate the class to which it belongs. With tetanic spasms, you suspect strychnia; with narcotic stupor, opium; with salivation, mercury; with inflammation of the mucous membranes, arsenic; with bloody stools and bloody urine, cantharides; with delirium: belladonna, Indian hemp, hyoscyamus, &c.; with loss of muscular power: tobacco, conia, digitalis, or aconite; with gangrene of the limbs, ergot; and so forth. Lead poisoning shows itself by the blue line on the gums; mercurial poisoning by paralysis agitans; phosphorus poisoning by the necrosed jaw (an action which, however, is almost entirely local). And yet even here it is necessary to be aware that it is possible to draw too fine a line of demarcation, for the general symptoms of one poison may be and often are the occasional symptoms of others. Tetanus, for example, the general symptom of strychnia poisoning, is found occasionally as a symptom of poisoning by other alkaloids, and even by tartar emetic. In a case of poisoning by savin referred to one of the authors, the symptoms strongly pointed to strychnia. Again, extreme salivation may be an occasional symptom of iodide of potassium, perchloride of iron, belladonna, &c.

And here we must ask, in what way is this remote action of a poison brought about, and how is the influence of a poison thus conveyed?

Two answers have been given to this question.

1st. *That poisons are absorbed by the blood and carried by the circulation to the part where the remote action is set up.* And this view has been generally accepted since the famous experiments of Magendie in 1809.

Independently of how poisons have been administered, the analysis of the blood in poisoning cases, will very frequently prove their existence in the general circulation. Magendie showed that even when a limb was merely connected with the body by quills placed in the large vessels, glass tubes having been substituted for quills in the later experiments, the poison continued to act, whilst it has been proved that even prussic acid, introduced into the stomach by a fistulous opening, is innocuous, provided a ligature be placed round the vessels passing from the stomach to the liver. Within one minute, however, after the ligature is removed, the poison will begin to act (Blake, "Ed. Med. and Surg. Journal," vol. liii., p. 45). Thus we are led to believe (*a*) that poisons are absorbed and conveyed through the general system by the circulation to the special organ upon which they act; and (β) that the fatal action of a poison is the result of its absorption. With these facts before us, we can understand how sucking a poisoned wound, or applying a ligature may save a life.

2ndly. *It has been stated that the action of the poison on the part to which it is applied is propagated by the nerves to the nervous centres, and from them reflected to the remote organs.*

Those who believe in this action of nerve communication or sympathy, urge in support of it the amazing rapidity with which prussic acid frequently proves fatal, an action compared by Magendie, in point of swiftness, to the passage of a cannon-ball or a thunderbolt. Such an action they say "is incompatible with its having followed the circuitous route of the circulation in order to reach the organs on which it acts, and there is no other conceivable mode by which it can act, except by the transmission of a primary local impulse along the nerves" (Christison). On the other hand it is urged that poisons inserted into a limb, connected with the body by nerves only, have no action. This was first proved by Emmert, whilst experimenting with the woorara poison. Further, it has been proved that the immediate contact of a poison with the substance of the brain itself may be unaccompained by any symptom of poisoning whatsoever. Whilst, however, holding most strongly that a nerve trunk is incapable of transmitting poison, experience compels us to admit the instantaneously fatal action of some drugs. Cases are on record where a dog has dropped down dead after having scarcely swallowed a dose of prussic acid two seconds. With no other poison with which we are acquainted is the action so extraordinarily rapid as it is with prussic acid. This cannot, it is manifest, be due to any transference of the poison by the circulation if the ordinarily taught facts of the circulation be correct; and hence, although the action must be and is excessively rare, the case of prussic acid suggests the possibility of poisons destroying life by a sudden nervous shock. Nor indeed is there any difficulty in admitting that under exceptional circumstances such may be the case, when we remember how fatal the sudden shock produced by mechanical injuries, or by the hearing bad or startling news occasionally proves. But there are difficulties even with prussic acid in admitting that the nervous shock is independent of the circulation. An ounce of prussic acid may be placed in the stomach of a dog, as we have said, provided the portal vein and œsophagus be tied, without any symptoms of poisoning being produced—or at any rate no symptoms occurring until such time as the collateral circulation brings the poison into the system; but the moment the ligature is removed from the portal vein, the dog falls down dead. This experiment certainly throws a doubt on any conveyance of a poison other than by the circulation, and leads us to ask whether the generally accepted physiological facts relative to the time of the circulation and the period necessary for the transit of blood from place to place may not possibly require some modification.

Circumstances Modifying the Action of Poisons.

I. *Quantity.*—As a rule, the greater the quantity of a poison taken, the more severe are the symptoms, and the more rapid their action. But this is by no means always or necessarily the case. A large dose of arsenic may fail to destroy life from the vomiting that it produces, whilst a small dose, failing to set up vomiting, and consequently retained by the stomach, may prove fatal. The dose, again, largely regulates symptoms. Many poisons which in large doses act on the nervous system, act in small doses on the alimentary canal. Our colleague, Mr. Rodgers, informs us of a remarkable case in his practice, where a woman was apparently suffering from all the effects of an irritant poison, with symptoms of considerable severity, produced by sulphate of magnesia, given to her by her husband in small and very frequently repeated doses for a long period, and introduced with criminal intent into every article of her food. When the fact was discovered and means were taken to prevent its further administration, the symptoms entirely disappeared. The modifying action of dose, again, is well illustrated in the case of oxalic acid, which, in a large dose, may kill by shock; in a smaller dose by its action on the heart; in a still smaller dose by its action on the brain and nervous system, producing violent tetanic spasms; and in a yet smaller dose still, destroying life with all the symptoms of pure coma.

II. *Molecular Form or Physical Condition.*—A poison in the state of a gas or vapour is, of all forms in which it can be taken, the most active. A poison capable of being volatilized is more energetic in its action when inhaled in a vaporous state than when swallowed as a solid or liquid. Next to the gaseous condition a poison in solution is the most active; absorption is easier, and contact with a larger surface more certainly secured. Whilst, lastly, a poison insoluble in water or in all the fluids of the digestive tract is probably inert.

III. *Chemical Combination.* (*See* Compound Poisoning.)

(*a*) *The activity of a poison may be increased by chemical combination.*

Such happens when *the solubility* of a poison is increased. Morphia, for example, in combination with hydrochloric or acetic acids, is more soluble than when in a free state, its activity being thereby intensified. It is also well to remember that the acid juices of the stomach or of the skin are capable of forming soluble salts with certain poisons, and so by this means increasing their activity.

(*β*) *The activity of a poison may be decreased by chemical combination.*

This happens specially with poisons which act locally. Sulphuric acid and caustic soda, when combined, form a gentle aperient, the one neutralizing the other. And again, whenever combination decreases the solubility of a poison, it decreases its activity in the same ratio. Sulphate of baryta is innocuous, because insoluble; but both baryta and sulphuric acid are deadly poisons.

(*γ*) *The activity of a poison may be modified by chemical combination.*

If as, for example, with arsenite of copper, both elements of the compound be poisons, we may have mixed symptoms, or the symptoms of the most active, or symptoms peculiar to the chemical mixture.

IV. *Mechanical Mixture.*

If the mechanical mixture serves in any way to shield a poison, its intensity of action is thereby diminished. Thus arsenic has been given in a suet dumpling without producing any effect. This is the explanation too of the delay in the commencement of the symptoms caused when a poison is taken with, or directly after a meal, or when administered mixed with oil or mucilage. The poisonous action further is usually lessened by dilution, although this is not always the case, prussic acid being a notable exception.

V. *The method by which, or the part to which the poison is administered.*

(*a*) First in order of activity is *the insertion of a poison into a wound,* or *its application to the lungs as a gas or vapour.*

The activity of morphia when injected subcutaneously (provided the wound does not bleed too freely, so as to wash the poison away) is an instance of the former; and the intensity of the action of sewer gases an instance of the latter.

(*β*) *The application of a poison to serous membranes* stands next in order. Oxalic acid injected into the peritoneum is infinitely more rapid in its poisonous and destructive action than when merely swallowed.

(γ) *Their application to mucous membranes* comes next; as *e.g.*, when a poison is swallowed, and so applied to the stomach and intestines. Under these circumstances the intensity and rapidity of the action of a poison is infinitely less than in those before mentioned. It is well known that a large quantity of the poison of the rattle-snake may be swallowed with impunity; whereas the smallest possible quantity injected into a vein is certain to be fatal.

(δ) And lastly, in point of order, is *the application of the poison to the unbroken skin.* For here the action is excessively slow, and oftentimes quite inert.

The intensity of action of some poisons—such, for example, as the mineral acids—will depend on two circumstances:—(1) The *extent of surface* destroyed; and, (2), *the part* to which it has been applied.

Poisons, as before remarked, have no action when applied simply to nerve-tissue.

VI. *Habit.*

It may be broadly stated that the habitual use of a poison tends to decrease its activity of action. At any rate, there is no doubt this rule is true of *organic* poisons. No one doubts the stories of De Quincy, and of other opium eaters. We know too well the enormous quantities of laudanum given to and borne by children in factory districts to keep them quiet. The large quantities of alcohol the confirmed drunkard consumes, as well as the enormous amount of tobacco smoke the inveterate smoker can inhale, are well known as further illustrations of the power of habit. But we must not forget that although habit begets this tolerance, a serious change in the constitution is often brought about by their agency. The disturbed digestion and enfeebled mind of the opium-eater, and the cirrhosis of the "gin drinker," are proof that habit may ward off for a time the evil day, but cannot altogether prevent it.

How far, however, habit can decrease the activity of *inorganic* poisons is we consider a matter of question. The truth of the old stories of the Styrian arsenic eaters, and of the Turkish corrosive sublimate eaters, may fairly be regarded as open to grave doubt. Certainly, one's experience of the action of some inorganic poisons used in the arts (*e.g.*, carbonate of lead and arsenite of copper), does not lead us to believe much in the power of habit in decreasing the activity of mineral poisons. Still, a celebrated French toxicologist (M. Flandin, "Traité des Poisons") informs us that he has been able to train animals to bear large, and even enormous doses of arsenic. One of the authors has pointed out the ease with which animals can be trained to breathe in an atmosphere containing a quantity of sulphurous acid, that would prove immediately fatal to those unaccustomed to it.*

VII. *Idiosyncrasy.*

Whilst *habit,* as we have said, tends to *diminish the activity* of poisons, *idiosyncrasy,* on the contrary, has a tendency to *increase their activity.*

As a familiar illustration of the influence of idiosyncrasy, we may mention the varied and well-known effects on different persons of the volatile oil of grasses, or of their pollen, as many believe, inducing in some severe catarrhal symptoms (hay fever), but apparently having no action upon others. It is not uncommon to find that a small dose of mercury, which in most people would merely act as a mild laxative, will in others produce alarming salivation. Nor can it be other than to peculiar idiosyncrasies that we can trace the different actions of alcohol. A debauch that would kill one man, does not apparently affect another. Christison tells a remarkable case of a man who took an ounce of solid opium without any effect, although he was quite unaccustomed to its use. The peculiarities of idiosyncrasy are to be noticed in the different effects of drugs. There are cases on record where Epsom salts has been known to act as a narcotic, and opium as a purgative. Again, susceptibility to the action of poisons is ordinarily found to be increased by age. An old person is far more easily affected by opium than a young adult. Again, some things, according to Foderé, act as poisons to some animals, but not to others. Hogs, he says, can eat henbane; pheasants, stramonium; and goats, water hemlock, with impunity. Ogle has proved that rabbits can live on belladonna, whilst Mitchell asserts the immunity of pigeons to morphia. Christison doubts the accuracy of some of these assertions. But in every-day life experience proves that it is no mere old woman's saying, that "What is one man's meat, is another man's poison;" for we find cases occasionally where mushrooms and pork and shell-fish act as violent irritant poisons to one person, but have no action on a second. These peculiarities of individuals it is most important should be borne in mind in medico-legal inquiries, as otherwise symptoms due to quite different causes may be attributed to the effects of poison.

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* On Vitiated Air, by C. Meymott Tidy, M.B., 1873. A paper read before the Association of Medical Officers of Health.

VIII. *Health of the Individual.*

Usually the intensity of the action of a poison is impaired by disease; but this is by no means a universal rule.

(*a*) The susceptibility to the action of poisons may be *decreased* by disease.

This "*tolerance of drugs*," as it is called, is very remarkable in the case of both organic and inorganic poisons, but especially in the former. In dysentery, tetanus, mania, cholera, hysteria, and delirium tremens, there is a remarkable tolerance for opium. In typhoid fever stimulants can be borne in enormous quantity. In diseases of the lungs there is a special tolerance for antimony. In spinal paralysis large doses of strychnia may usually be given without any bad results. In tetanus, and also in continued and yellow fever there is ordinarily diminished susceptibility to the action of mercury. No doubt also persons in a state of melancholia are less susceptible than others to the action of poisons generally.

(β) The susceptibility to the action of poisons may be *increased* by disease.

This would necessarily occur where poisons are administered which would increase the symptoms of a disease from which a person was already suffering:—*e.g.*, in a person suffering from inflammation of the stomach or bowels, an irritant poison would induce symptoms of more than usual irritation. The experience of the authors is that "like does not cure like." Again, in a patient predisposed to apoplexy, a very small dose of opium has been known to prove fatal. It is stated that in patients suffering from granular degeneration of the kidney a small dose of calomel will sometimes produce alarming symptoms.

IX. *Sleep.*

The action of drugs is impaired by sleep, for sleep may be regarded as a state of diminished activity. It is, of course, well known that a purgative does not act so rapidly during sleep as when the person is awake. The combination of opium with arsenic, *e.g.*, retards the action of the arsenic by reason of the narcotic action of the opium.

X. *Food.*

The action of a poison is usually retarded if it be taken with food or on a full stomach, perfect contact with the mucous membrane being thereby prevented. The action, of course, is frequently mechanical, but not necessarily so.

Circumstances leading us to suspect the Administration of Poison.

When called to a suspected case of poisoning, make notes at the time, or at the earliest possible opportunity, briefly and chronologically, of everything that strikes you as important. Only enter facts in your notes, and let them be perfectly free from all technicalities. Above all, if you have a suspicion of foul play, watch the case closely, but unless your suspicion is confirmed by well-observed facts, do not mention it to anybody, and under no circumstances talk about it, or publish it in the neighbourhood or elsewhere. Your first duty is to save the life of your patient, your second is to assist justice in exposing and punishing crime.

The first question we must consider is—What are the circumstances that would lead us to suspect poison had been administered?

I. *The symptoms appearing suddenly in a person otherwise healthy, and their progress towards a fatal termination being rapid.*

When poisons are given with criminal intent, they are as a rule given in large doses, and consequently begin to act soon after they are administered. But besides the modifying actions of sleep and food, there are other important facts to be noticed.

1st. *Poisons may be slow in their action*, especially when given in small repeated doses. This is the case with such poisons as arsenic, mercury, phosphorus, and nitro-benzol. With bad and poisonous food, the action is often very tardy. The subject of slow poisoning is bound up so curiously with popular literature and superstition, that it is no easy matter to say where falsehood ends and truth begins. Still chronic poisoning demands serious attention from the fact that such questions are not unfrequently referred to the Medical Jurist. The time occupied by a poison in bringing about a fatal result necessarily varies. There is always in these cases a great difficulty in proving guilt, because it is necessary to prove the absence of tendency to disease. And, again, cases of chronic poisoning may occur in those engaged in some trade or another, where the air may be charged with minute quantities of irritant poisons, such as are used in the business.

2nd. *Many diseases come on very suddenly*, such as acute diseases generally. Cholera and other severe epidemic diseases, and often the exanthemata are exceedingly sudden in their commencement.

Again, the person attacked may not be "otherwise healthy." Poison may be administered when a person is ill, and thus suspicion be disarmed. Still, if violent symptoms, such as vomiting and purging on the one hand, or giddiness, delirium, or unusual drowsiness on the other, set in without any obvious or natural causes to explain their occurrence, we are more than justified in instituting a strict watch. Again, cases are on record where the health has been undermined by the slow exhibition of one poison as, *e.g.*, tartar emetic, whilst the actual death has been brought about by a second poison such as strychnia. As regards rapid and sudden death as a proof of poisoning, we must bear in mind that whilst, on the one hand, in many cases of poisoning death is very slow, on the other hand, in many cases of disease, death is sudden and unexpected.

II. *In a case of poisoning the symptoms will probably be dated as coming on soon after the taking a certain meal or some article of food.*

It may be regarded as strong evidence against the suspicion of poison being the cause of death, if no food or medicine has been taken for hours before the symptoms set in. On the other hand, it is a strong argument in favour of the suspicion, if the symptoms set in speedily after taking food or medicine. It is always advisable for the chemist or general practitioner to remember, supposing that the poisonous symptoms commenced after taking a dose of medicine, that the malicious may put poison into the very medicine that has been sent a patient, and so endeavour to disarm suspicion against the true criminal.

But we must remember

(*a*) *Symptoms may come on after food or medicine which merely resemble those of poisoning.*

Many natural disorders come on after a full meal, such as, for example, apoplexy, or rupture of stomach from over distension after long disease. Unwholesome and bad food may produce a sudden attack of English cholera. Immediate death, too, has more than once followed the mere drinking a draught of cold water when a person was over-heated.

(*β*) *Poisons may be administered in other ways than by the mouth.*

They may be applied to ulcerated surfaces, or they may be injected into the vagina or rectum, or under the skin, or they may be inhaled. The administration of chloroform or nitrite of amyl during sleep, and especially if the person slept with the mouth open, would be a matter of no difficulty.

III. *Symptoms coming on after a meal of which many have eaten, will be more or less complained of by several or by all who have partaken of it.*

This is a very strong reason indeed for suspecting poison, whilst, on the contrary, others having partaken of the same meal, and no bad effects resulting in their case, would lead us to an opposite conclusion. And yet this evidence is by no means conclusive. Poison may be in one part of a dish and not in another, or the symptoms may vary owing to different idiosyncrasies. Nor must we forget that certain foods, such as sausages, cheese, shell-fish, &c., are, at certain times, so unwholesome as to give rise to violent symptoms of irritant poisoning. In the case of cheese such effects are very common. If a dish has been mixed with poison and several have eaten of it, probably the person who has eaten most will fare the worst, although this is not necessarily the case, because, as before stated, a small quantity of a poison may prove fatal, whilst, if a large quantity be swallowed, it may be vomited, and so produce no bad effects.

Symptoms of Poisoning.

The symptoms produced by poisons vary. It may be well here, as far as possible, to systematize the general symptoms produced by poisons, reserving for our remarks on each, any special characteristics that its symptoms present.

I. *Symptoms of Corrosive Poisons.*

(*Strong mineral acids, caustic alkalies and their carbonates—strong solutions of oxalic acid, corrosive sublimate, chlorides of antimony, zinc, tin*, &c., &c.)

Immediate burning pain in the mouth, throat and stomach, rapidly extending to the abdomen. Vomiting occurs very soon, followed by purging. Blood is discharged pure or mixed. The mouth and throat will be found to be corroded. Speedy death will occur either from (1) shock, or (2) exhaustion, or (3) from perforation of the stomach or intestinal canal, or (4) from starvation by stricture of the gullet, or (5) from suffocation from injury to the glottis or windpipe.

II. *Symptoms of Irritants.*

(*Arsenic, mercury, tin, lead, copper, phosphorus, iodine, cantharides, irritant gases.* Every corrosive acts as an irritant, inflaming ome parts whilst it destroys others, but there are many irritants that are not corrosives, such as salts of baryta, cantharides, &c.)

The symptoms vary considerably both in intensity and rapidity of action. These differences depend largely on the solubility of the poison and the quantity swallowed. As regards *solubility* and its influence on the commencement of the symptoms, we may note that with some poisons, such as arsenious acid, a considerable delay may occur from their insolubility in water or in other liquids. The intense pain and dryness in the throat, usually produced by irritant poisons as soon as swallowed, is often, by reason of their insolubility, absent in the first instance, but supervenes in a later stage when the poison, dissolved more or less in the gastric fluids, comes in contact with the gullet in the act of vomiting. This broad distinction between corrosives and irritants may be noted, that with the former the symptoms are usually immediate, whilst with the latter considerable delay in their appearance is not uncommon. By this test, therefore, we should be able to say whether a poison that had been swallowed was calomel or corrosive sublimate.

After a certain time pain and great dryness of the throat is complained of. There is commonly great thirst, nausea and vomiting,—pain and extreme tenderness of the abdomen, the pain being increased by pressure, purging with tenesmus, the discharges usually being mixed with blood, —hiccup, loss of voice, cold sweats, an irregular thready pulse, pain in the region of the kidneys, with strangury. The patient, as a rule, is sensible to the last. Death will occur either from (1) shock to the nervous system, or (2) convulsions, or (3) exhaustion, or (4) starvation, or (5) suffocation from inflammation of the upper part of the windpipe.

And here it is important to note two facts. (1) That anomalous symptoms occasionally occur as the result of irritant poisoning, such as coma, paralysis and tetanic spasms; and (2) that some diseases such, for example, as gastro-enteritis, complicated with acute nephritis, closely simulate, as Dr. Anstie pointed out, cases of irritant poisoning. ("Medical Times and Gazette," March 2, 1861, p. 239.)

III. *Symptoms of Narcotics* and *Narcotico-acrids.*

Of these we may distinguish several classes. The symptoms are more easily mistaken for disease than those produced by corrosives or irritants.

A. *Poisons that produce Sleep.*
(Such as *Opium.*)
Immediately, or in a short time after their administration, there is giddiness, headache, dim sight, protrusion of the eyes, contraction of the pupils, noises in the ears, and drowsiness, passing on to insensibility. Vomiting is rare, and if it occurs, is a favourable symptom. There is rarely either paralysis, convulsions or tetanic spasms. Pain and convulsions, however, are occasional symptoms towards the end of a case. Death may result from (1) apoplexy, (2) collapse, (3) apnœa, or (4) convulsions.

B. *Poisons that produce Delirium.*
(Such as *Belladonna, Stramonium, Hyoscyamus.*)
There is delirium, illusions of the senses, thirst, dryness of the throat, and dilated pupils. The other symptoms are very varied. Irritation of the stomach and bowels, and dysuria are not uncommon. Sometimes we may have tetanic spasms, paralysis of the motor and sensitive nerves, coma and insensibility. Death generally is ushered in by comatose symptoms, and rarely by convulsions.

C. *Poisons that produce Excitement.*
(Such as *Alcohol, Ether, Chloroform, Indian Hemp.*)
Excitement of the brain and circulation, followed by great muscular weakness, nausea and vomiting, double vision, and want of co-ordination of movements, the patient at last passing into a condition of more or less complete coma, are the usual effects to be noticed. The smell of the breath will often be a well-marked diagnostic sign. These inebriants may to a certain extent act as irritants, the irritating action being very partial, and confined to the stomach, or, if inhaled, to the air passages. Death may result (1) suddenly from shock, but more generally arises (2) from cardiac paralysis, or (3) a state allied to apoplexy.

D. *Poisons that produce Convulsions.*
(Such as *Strychnia,* and substances containing it.)
The symptoms are violent paroxysms of rigid convulsions with great suffering, the risus sardonicus, tetanus or lock-jaw ; the mind, as a rule, not being much affected. Death results (1) from exhaustion, or (2) from suffocation, (3) or more commonly from interference with the free action of the respiratory muscles (for modes of death by strychnia, *see* "Lancet," July 19, 1856, p. 72). (Tetanic convulsions simulating poisoning by Strychnia, *see* Dr. Roberts, "Lancet," March 27, 1858.)

E. *Poisons that kill by Shock.*
(Such as *hydrocyanic acid,* the action of which is usually so rapid as not to allow of special symptoms.)

F. *Poisons that produce Asphyxia.*
(Such as *carbonic acid, carbonic oxide, sulphuretted hydrogen,* &c.)
Suffocation, with headache and drowsiness, are commonly found. Death is caused by asphyxia.

Lastly, it may be noted that if a medical man has reason to suspect that a person is being poisoned, it will be advisable, if possible, to secure the services of a confidential nurse, and to order that the urine and vomited matters should be saved, the examination of which in all probability will yield us confirmatory evidence or otherwise.

The General Treatment of Cases of Poisoning.

And now we may examine the general principles that should guide us in our treatment of a case of poisoning, provided the patient be living. The indications are four:

1. Get the poison out of the system as soon as you can.
2. Neutralize what you cannot remove.
3. Favour the natural elimination of the poison.
4. Combat any dangerous symptoms that may arise.

1. *Remove the poison as soon as possible, either by mechanical means or by exciting the action of the Stomach to discharge it.*

(*a*) Emetics.

Emetics should not be given in cases of poisoning with the mineral acids, or with the caustic alkalies, or with oxalic acid, as in these cases the proper treatment is to neutralize the poison. Again, with prussic acid, it is useless giving an emetic, as the patient would be dead before it acted. In cases of poisoning by the salts of the alkalies and the alkaline earths, by phosphorus, arsenic, and the preparations of lead and copper, and by such poisons as opium, belladonna, &c., an emetic is indicated. We are strongly of opinion that the use of tartar emetic as an emetic should be discouraged. Torpidity of the stomach may interfere with vomiting, and if the antimony be retained the case is rendered more desperate than it was before it was given. We should recommend half-dram doses of sulphate of zinc, or if this be not at hand, mustard and water in the proportion of a teaspoonful of mustard to a tablespoonful of water, repeated every quarter of an hour. We object to the use of sulphate of copper altogether. It is itself a poison, and is uncertain in its action. If, however, it be given for want of anything else, 10 grains will be a sufficient dose.

(*β*) *Stomach-Pump.*

Every medical man should have a stomach-pump in readiness and *in working order.* Unfortunately it is not always applicable in the treatment of poisoning, from the destructive action of some poisons, and the rapidity of the action of others. Its use is specially indicated in cases of poisoning by strychnia, alcohol, liquid chloroform, and opium, and in the *early* stages of arsenical poisoning, by which means portions adhering to the stomach may possibly be washed away. It must not be used under any circumstances in poisoning by the corrosives, otherwise additional injury will be inflicted.

To introduce the stomach-pump, it is often necessary to place a gag with a hole in it to prevent the tube being bitten in the patient's mouth; but if this can be dispensed with, so much the better. It is generally advisable to tie the gag in. Let the patient sit in a chair or lie upon a couch, with the head well thrown back. Having warmed and oiled the tube, and curved its extremity somewhat abruptly, pass it to the back of the throat, and as soon as this is done bring the head a little forward and gently push the tube so that it may pass along the vertebræ into the pharynx. A slight difficulty may occur for an instant at the larynx, but it will only be momentary. Keep the tube exactly in the median line. If the tube had passed into the trachea, the urgent dyspnœa would at once show your error. Before you withdraw any fluid from the stomach, inject into it one or two pints of warm water, and take care never to withdraw at any time as much fluid as you have injected. This injection and withdrawal may be done several times. If the eyes of the tube become choked with undigested matters, immediately reverse the action of the pump so as to drive the fragments out. If this fails, withdraw the tube and clean it. With children the best tube to use is a large gum elastic catheter, adapted to the pump with a piece of india-rubber tubing.

To induce vomiting, however, such simple means as tickling the throat as far down as possible with a feather or merely with the finger may be often resorted to with advantage.

2. *Neutralize the poison you are unable to remove.*

This is effected by *antidotes.* An antidote is defined by Johnson as "a thing given in opposition to something else." There are three kinds of antidotes; chemical, mechanical, and physiological.

(α) *Chemical Antidotes.*

Take care your antidote is inert, or if it be poisonous, a poison that is certain to be neutralized by the poison that has been already taken. It is not sufficient that a chemical antidote should merely render a poison insoluble in water, but also that it should render it insoluble in the fluids of the digestive tract.

As illustrations of chemical antidotes may be cited, chalk and magnesia for acid poisons; lemon-juice or vinegar for caustic alkalies; alkaline sulphates for salts of lead and baryta; common salt mixed with milk and white of egg for nitrate of silver, corrosive sublimate and verdigris; tannic acid for morphia, &c. The fresh hydrated sesqui-oxide of iron formed by precipitating the tinctura ferri perchloridi with excess of ammonia has been much praised by many as a chemical antidote for arsenic and metallic poisons generally.

(β) *Mechanical Antidotes.*

Their influence is essentially protective, the poison merely by their means being mechanically held in suspension. Flour and water, hydrate of magnesia, a mixture of chalk, castor oil and water are illustrations of mechanical antidotes. In poisoning by phosphorus, corrosive sublimate, cantharides, &c., such antidotes are most useful. In some cases of poisoning, and notably with strychnia, the use of animal charcoal diffused in water, first suggested by Dr. Garrod, is most efficacious in removing the poison by its power of absorption, and when absorbed ceases to be deleterious.

(γ) *Physiological Antidotes.*

A most elaborate series of observations on physiological antidotes has lately been made by a committee under the presidency of Dr. Hughes Bennett. These are recorded in detail in the "British Medical Journal." We caution the reader, however, against putting too much reliance on physiological antidotes, and especially upon results gathered from experiments on animals. It is difficult to poison a dog with arsenic, or a rabbit with belladonna: it is easy to poison a rabbit with arsenic, and a dog with belladonna, and a man with either one or the other. Belladonna has no action on the pupils of pigeons, nor are they influenced by morphia, stramonium, or hyoscyamus. Dogs will take atropine, and horses strychnia, in enormous doses.

Some care, too, is needful before we conclude that a drug which in one respect seems *antagonistic* to another drug, is necessarily an *antidote* for it. This subject, however, is one we consider that at present, at any rate, rather belongs to the physiologist than to the medical jurist; for the experiments have very little more than physiological interest. Because one thing contracts the pupil, and another thing dilates it, it is folly to say that they are antagonistic drugs. And even allowing such antagonism to exist, the balance between the two poisons is too fine to allow us to regard them as antidotes. Possibly, for example, atropine, in some fixed proportion, may be an antidote to morphia; but if you give too much, the patient may die from the poison given as the antidote. Under physiological antidotes, however, we may include the action of ammonia in poisoning by hydrocyanic acid, and strong coffee or tea in opium or belladonna, &c. And that these are useful, there can be but little doubt.

3. *Favour in every possible way the decomposition and elimination of the poison.*

On this question of poison elimination some difference of opinion exists. Dr. Anstie appears to hold that there is no tendency in the unaided animal organism to get rid of poisons, and that remedies administered with the object of assisting elimination are, as a rule, powerless. Such a view seems contrary, to say the least, to the general experience that poisons pass out of the body through the agency of all the excretions. The kidneys, of all eliminatory agents, seem the most powerful, and hence, in toxicological investigations, we always examine the urine, if possible, for the poison. Alcohol, we know, is carried away by the breath, mercury by the skin, and most poisons by the bowels. The fact that some poisons are carried away by some of the secretions in preference to others, suggests the rule, in the treatment, to stimulate that organ which is most powerful in its action of getting rid of the poison. To eliminate lead from the system, it is customary to give iodide of potassium, although this may be regarded as a chemical antidote. Again, in opium poisoning we constantly rouse the patient, and make him walk about, to assist in the oxidation of the opium.

4. *Lastly, combat special symptoms that may arise.* And here it is difficult to give specific instructions. In alcohol, on the one hand, and in opium on the other, your chief reliance must be placed. Nor must the importance of galvanism be overlooked.

One general recommendation in all cases of poisoning may be made here: that is, never neglect by every possible means to preserve the temperature of the body. ("Dublin Medical Journal," 1865, p. 435.)

Analytical and Microscopical Investigation.

We reserve for the next chapter the chemical processes to be adopted in a toxicological investigation, limiting our remarks here to such general questions as may be suggested by the evidence or by the results of the analysis.

1. *Supposing a poison is found.*

(*a*) If it be in a stool or vomit, Was the vessel that contained them perfectly clean before they were put in?

(*β*) If it be found in the food of which a person had partaken, Was it maliciously introduced, in order to inculpate an innocent person? This, of course, will be a question for a jury to decide. It should be remembered that the presence or absence of poison in food must always be considered in conjunction with the circumstance that from unequal distribution it may very likely be present in one part of a dish but not in another.

(*γ*) If the poison be found in the urine, it is of all evidence the most important, because it is proof that the poison has passed through the body.

A poison being found in the stomach after death, the counsel for the prisoner will probably suggest the following difficulties that you will have to meet.

1st. That the quantity found is very small, and insufficient to account for death.

And this difficulty we must consider carefully.

Say we have found a poison, and we are asked—Is the quantity found, or the quantity that was probably swallowed, sufficient to cause death or to produce the symptoms described? Here, then, it is advisable to have clearly before your mind certain facts.

A. *All the poison that is swallowed is rarely absorbed.* Some is got rid of either by

(*a*) Vomiting, or

(*b*) Diarrhœa;

(*c*) Whilst some, if death be rapid, remains in the stomach and intestines, and may be found there.

B. *The portion of the poison absorbed is not equally distributed over the whole body.*—For it is well known that with many poisons the liver becomes specially the home of the poison after absorption.

C. *As soon as a poison is absorbed by the system, elimination from the system commences.*

Arsenic, for example, is often entirely eliminated from the system after a fortnight.

And hence note

(*a*) From the time a poison is absorbed, the quantity in the body begins to diminish.

(*b*) That death may be caused by a poison which is not discoverable by analysis after death.

(*c*) That it is not necessary, in order that a poison should destroy life, that it should be in the body up to the last moment of the person's existence. The poison strikes the blow,—this develops diseased action, and death results from the disease; but the poison struck the blow, and was therefore the true cause of death.

D. *The portion of poison found in the stomach and alimentary canal constitutes that portion of the poison not absorbed, and therefore the portion over and above that which was necessary to destroy life.* This excess, discovered by analysis, in the digestive tract, may form but a small portion of that swallowed. Hence the discovery of a very small portion in the stomach is no criterion of the quantity taken.

E. The quantity found in a given organ (say the liver) is only a portion of the poison absorbed, and consequently may form, and probably does form, a very small part of the total poison swallowed. You cannot, therefore, judge of the amount of a poison swallowed by the quantity found in any one organ.

F. *The action of poisons on different persons is very variable.* What will kill one man, will scarcely affect a second. It is unadvisable, therefore, in a court of law, to say what is the minimum dose (as you will often be asked) that will destroy life. All you can state is, what is the smallest dose that has destroyed life—what is the average dose—and what is the largest dose from which a person has recovered.

In every case where possible, estimate the quantity of poison found in the contents of the stomach and alimentary canal, and also the quantity found in any special organ (as the liver) submitted to analysis. And in drawing conclusions from your analysis, carefully bear in mind the following circumstances :—

(*a*) If there has been vomiting and purging, it is impossible (unless all the vomits and stools are examined) to hazard a conjecture as to the quantity originally taken from the amount found in the alimentary canal. All you can say is that it is a quantity greater than that which you have found.

(*b*) The unequal distribution of a poison and its constant elimination prevents us giving an opinion of the quantity absorbed, and much less of the quantity swallowed by the amount we find in certain organs, or portions of organs. What we find by analysis in certain viscera is only a portion of that which was absorbed, and that only a portion of what was swallowed.

(*c*) If there has been no vomiting and no diarrhœa, and on analysis no poison can be found in the stomach and intestines, it follows that all that was taken has been absorbed. This quantity cannot be estimated accurately, because it is unequally distributed, unless the whole body be submitted to examination, and even then the process of elimination would render the experiment imperfect.

(*d*) The quantity taken, minus that absorbed, and which was really the portion that killed, may be estimated if—

(1) The vomits and stools and the contents of the digestive tract be examined, if there has been vomiting and purging ; or,

(2) The contents of the digestive tract alone, if there has been no vomiting or purging.

Hence our answer to the objection of counsel that the quantity found is very small and insufficient to account for death, is that the quantity found is only a portion of the quantity swallowed, and very possibly bears little or no relationship to it ; and further, that the portion found in the stomach was not the portion that destroyed life, but the excess over and above that which was needful to bring about a fatal result.

Further, the analysis of different foods and medicines taken by the deceased is most important, as this may enable us to find the true source of the poison, and thus establish guilt or innocence. By comparative analyses of this kind, in a case submitted to one of the authors, he was enabled entirely to clear a person in custody on a charge of murder, and to prove the source of the poison from which the deceased died.

2ndly. It may be urged by counsel that some poisons are natural constituents of the body. This defence requires consideration.

(*a*) With respect to *arsenic*.

Orfila at one time imagined arsenic to be a normal constituent of the body ; but he afterwards admitted his error, when proof was demanded by the French Institute. "Superphosphate," which is largely used as manure, is manufactured with common oil of vitriol. This usually contains notable quantities of arsenic, derived from the pyrites used in its manufacture. It is supposed that the arsenic which thus gets into the superphosphate contaminates the plants grown on the soil to which it is applied. But this, we are convinced, is an error. Again, it is stated that arsenic is to be found in the fur of tea-kettles and boilers; but it can scarcely, at any rate, be in such a quantity as can possibly prove injurious. Chalybeate springs, it is true, frequently contain arsenic, but only in such quantities that a person would have to drink (taking an extreme case) some seventy-nine gallons, in order to have swallowed the 1-100th of a grain. Even in the mountain stream in Cumberland (Whitbeck), where probably more arsenic is found than in any other, the water has never been found to prove poisonous to anything but ducks. ("British Medical Journal," Oct. 18, 1862, p. 425.) Dr. Taylor has stated that a notable quantity of arsenic may be found in Thames mud. The authors have failed to find any trace of it.

(β) *With respect to Copper.*

Devergie, Lefortier, and Orfila consider it to be a normal constituent of all tissues, and of the blood. They have also found it in the sweat. Signor Cattanei says it is not present in new-born infants! M. Barse has recently confirmed these investigations; but English experimenters do not seem to have discovered it at all. We can, however, quite imagine traces of copper to be present in the body, derivable from two sources:—(1) From articles of food; and (2) from copper vessels used in cooking. (*Vide* "Med. Times," Oct. 19, 1844, p. 55.)

(γ) *With respect to Lead.*

The same chemists who found copper, have found lead. But there is, we consider, much reason to doubt their results, although it is true that the lead-pipes and lead-cisterns used for water, and especially if they are badly tinned, may be a means of conveying lead into the system.

(δ) *With respect to Manganese.*

In small quantities this has, no doubt, been found in the hair, in some urinary calculi, and in gall-stones.

We are not aware of questions being raised as to any other poisonous bodies than those we have mentioned being natural constituents of the body.

3rdly. *It may probably be urged by counsel that the symptoms described do not coincide exactly with the poison discovered;* and hence that the poison found is the true cause of death is not proved.

In answer to this we must show the great variation in the symptoms that a known poison will produce, owing to the many modifying circumstances, to which we have already referred.

4thly. *Although the poison is found, may it not, a counsel may urge, have been maliciously introduced after death?*

Such a thing has happened, although there is no case of such an act on record in England. Orfila, however, carefully investigated the subject; and although he found corrosive poisons, as well as some irritants, would produce a change on dead tissue, still their action is strictly limited to the exact spot to which the poison is applied, no inflammatory appearance being visible beyond the spot, and the line of demarcation between tissue acted upon, and tissue unacted upon, being perfectly well marked and distinct.

2. *Supposing a poison is not found.*

It does not therefore necessarily follow that none has been taken, although we are of opinion that, with few exceptions, without there is chemical evidence to prove a poison actually present, no charge of poisoning should be regarded as proved. Circumstances of course may explain its absence in the stomach after death, and these have to be considered. It may be *discharged* by vomiting and purging, although with sparingly soluble poisons, such as arsenic, we generally find some particles glued to the stomach by the products of inflammation. It may have *evaporated*, as might happen with volatile poisons, such as hydrocyanic acid, chloroform, &c. It may be *absorbed;* and hence under all circumstances we should examine other organs besides the stomach. It may be *decomposed*, especially if a considerable time has elapsed between its administration and the fatal result. It is important, however, to remember (and we shall refer to the subject again), that some organic poisons, such as strychnia, are not destroyed by contact with *dead* animal tissues, although the tissues themselves may be in a state of active decomposition and decay. It *may have entered into new combinations*, an example of which is found in the conversion of arsenious acid into a sulphide. Corrosive sublimate again may be changed to calomel or even the metal be entirely reduced. Lastly, *the poison may be one which chemical analysis is unable to detect, or which, before death, has been entirely eliminated from the body.* Thus, for example, antimony may be taken and cause death; but its elimination will probably be complete if as long as a week intervenes between its administration and the fatal result (Mr. Herapath).

Experiments on Animals may furnish us with much useful information in cases of suspected poisoning, but their value must not be over estimated.

(*a*) Certainly if the food of which the deceased person had partaken proves fatal to some domestic animal, the evidence in favour of poisoning is strong. And, on the other hand, if an animal has eaten from the same food, and no symptoms of poisoning result, it must be regarded as strong evidence to the contrary. If you are told that the food which the friends believed caused the patient's death, also killed some animal that accidentally ate it, enquire most carefully into the symptoms that manifested themselves in the animal. And yet it must be remembered that some poisons seem to be inert on certain animals. Rabbits, M. Runge and Dr. Ogle tell us can live on the leaves of belladonna, hyoscyamus, and stramonium. Dr. Weir Mitchell has pointed out the comparative immunity from the effects of morphia enjoyed by pigeons. We have seen a mass of maggots feeding off wheat soaked in strychnia. Unfortunately, too, our knowledge of the action of drugs on animals is as yet sadly incomplete.

(*β*) The effects on animals of vomited matters and of the contents of the stomach, constitute, at best, very doubtful evidence. Animal fluids secreted during disease, especially if at all putrid, and at times even an ordinary vomit, will prove poisonous to animals. Morgagni has related a case where the bile from the stomach of a child, who died from convulsions in tertian ague, killed a cock that eat it, and two pigeons inoculated with it.

When you are called to a case of suspected poisoning, and you find the person dead, the following hints may assist you in note taking :—

1. Note down the time you were sent for, the time of your first visit, and the time the person died.

2. Enquire the time of the last meal or food or medicine taken before the symptoms appeared.
3. Note down everything the deceased was reported to have eaten during the last hours of life, and if any portions of these remain, take possession of them for further examination.
4. Enquire the time the symptoms first set in, and what remissions occurred.
5. Note whether anybody else partook of the last meal with the deceased, and with what results.
6. Note everything that is told you respecting the symptoms from which the deceased suffered from the time he was taken ill.
7. If vomiting occurred, save, if possible, the vomit, taking care especially to preserve any deposit in the vessel. If only stains from the vomiting exist, cut them out and preserve them. If there is any vomit left on the floor, soak it up with a sponge, and keep the sponge. If there is any urine, take charge of it at once. It is advisable to put these under seal before leaving the house.
8. Note the position of the body at the time of your visit.
9. Carefully inspect the room where the deceased is found. Preserve, without remark, all bottles, liquids, paper-packets, &c., that you find about; also any unwashed wine glasses or tumblers from which poison may possibly have been taken.
10. Note all you can learn respecting the previous illnesses of the deceased.
11. Put down in writing, and in their own words, all communications made to you by those in attendance.

Very important moral evidence may come under the notice of the medical jurist who may be called in to a suspected case of poisoning, and it is not right that he should neglect to attend to evidence of this nature. Such questions as these may possibly be of use in eliciting the history of the case.

1. Has there been any special enmity between the deceased and the person suspected?
2. Has the person suspected been dabbling with poisons, or purchased any under false pretences, as *e.g.*, saying it was to poison rats or mice?
3. Has he been making enquiries about poisons?
4. Has he interfered with the deceased having proper medical attention?
5. Has he given a false version of the symptoms, and such as to show acquaintance with the usual effects of the poison?
6. Has he shown any anxiety to prepare food, or convey it to the deceased?
7. Has he prevented friends or relations being sent for during the illness of the deceased?
8. Has he been desirous of getting rid of any article of food, &c., left, of which the deceased partook?
9. Has he hurried the funeral arrangements?
10. Has he attempted to tamper with any articles set aside for analysis?

11. Has he any interest in the death of the deceased (burial-club, life-insurance, &c.)?

12. Has he made any false statements to obtain a certificate of death?

In Cases of Exhumation.

1. Note the state of the coffin.
2. Preserve some of the earth around the coffin for analysis.
3. Let the body, if possible, be identified by a relative in your presence.
4. Never use disinfectants, but if necessary wear a charcoal respirator.

Post-mortem in Cases of Poisoning.

In a post-mortem examination, we recommend you to make notes during the operation—for notes and memoranda, to be admissible in a court of law, must be made at the time of the examination. Hence, you must not afterwards make "a fair copy" of your notes for use in the witness-box. The original notes, although not evidence, may be used if necessary to refresh your memory.

Previously to commencing a post-mortem, have six wide-mouthed, glass-stoppered bottles in readiness, taking care they are well washed and cleansed. Also provide yourself with string, candle, sealing-wax, and seal. After you have placed the viscera in the bottles, tie the stoppers down with string, using no paper or calico to tie over them. Then seal the bottles securely. If you have no seal at hand, a key does very well. Let no disinfectants of any kind be used during the post-mortem.

The following hints of what you are to note may be of use:—

1. Note the time after death that the examination is made.
2. Note the external appearance of the body, and the expression of the countenance. (In poisoning by corrosives, it appears anxious; by narcotics, placid; whilst where there has been convulsions it will often appear distorted.)
3. Note the presence of rigidity, or cadaveric spasm.
4. Note any marks of violence, blood stains, &c.
5. Note any appearances that may suggest murder or suicide.
6. Note the external appearances of the stomach. Ligature both ends. Remove it without opening, and at once place it in a clean stoppered bottle.
7. Remove the whole of the intestines, except the Rectum, and preserve them unopened in another bottle.
8. Remove and examine the Rectum for foreign bodies. The presence of hardened fæcal matter proves the absence of purging before death.
9. Note the colour of the throat, gullet, and wind-pipe, and examine them for corrosions and for foreign bodies.
10. Examine the Lungs, Brain, and Spinal Cord.
11. Remove the Liver and Gall-bladder, and preserve them for analysis.
12. Remove and preserve the bladder and its contents.

13. In the female examine the genital organs carefully, and look for foreign bodies.

14. Note all pathological appearances. Remember, you must endeavour to prove not merely that the deceased died from poison, but that death did not result from natural causes.

It was formerly believed that the bodies of persons who died from poison putrefied rapidly. This, however, is proved to be a mistake. Indeed, with some poisons, such as Arsenic, Chloroform, Strychnia, Chloride of Zinc, Corrosive Sublimate, etc., putrefaction seems to be delayed rather than hastened.

Lastly, never allow the bottles and the substances you intend for examination to be out of your custody for a moment—never leave them, except under lock and key; and let them all be carefully labelled.

We may here generalize on the post-mortem appearances found in cases of poisoning.

(A) *The Post-mortem appearances of Corrosives.*

The corrosive action may be extensive or limited. The tissues may appear softened, or hardened and shrivelled. Some portions of the coats of the stomach, or of the gullet may be destroyed, and perforations produced, whilst other portions may appear gangrenous. In the gullet, it is not uncommon to find a wrinkled worm-eaten appearance, due to the contraction of the longitudinal and transverse fibres, and the removal of patches of epithelium. Other parts will be found intensely inflamed, with an extensive extravasation of blood in the cellular tissue.

Note carefully *the changes of colour* induced in the tissues by the action of different corrosive poisons. The black, charred appearance from Sulphuric Acid; the yellowish, or yellowish green from Nitric Acid; the slate-coloured deposit of reduced Mercury or of the black sulphide from Corrosive Sublimate, are singularly characteristic. The hardened and crimpled appearance of the gullet is never noticed in disease, whilst gangrene of the alimentary tract is excessively rare.

A question, however, will probably arise whether perforation may not be produced by other causes than corrosive poisons.

1st. We note that perforation arising from ulceration, the result of idiopathic inflammation, is comparatively rare. And it may even be further stated, that perforation, resulting from the action of an irritant poison, is also very rare. In the case of perforation the result of chronic disease, the absence of any staining or of extreme general inflammation will be important signs. Further, of course, analysis will prove the absence of poison.

2ndly. Perforation arising from softening of the coats of the stomach during life and their consequent rupture is of occasional occurrence. The rupture often happens after a meal upon sudden exertion, and is accompanied with great pain, but without any diarrhœa, and probably with but very little vomiting. The patient, as a rule in these cases, dies in a state of collapse in from eighteen to thirty hours. This is very important to note, inasmuch as when such poisons as Arsenic have produced perforation, there are no cases on record where it has been caused in so short a time even as thirty hours after the poison has been swallowed.

In chronic perforating ulcers of the stomach, duodenum, &c., of which as many as twelve have been found in one stomach, the edges are generally greatly thickened, but very smooth, and more regular in form than those produced by the action of corrosive poisons. And, again, the perforations in these cases of disease are generally of a well-marked conical shape, from the peritoneal opening being smaller than those of the other coats. As a rule, too, there are but few signs of acute inflammation; indeed, not unfrequently, an unusual whiteness of the stomach will be apparent (Christison), whilst no poison will be found on analysis.

3rdly. Perforation may be produced *after* death by the solvent action of the gastric fluid. This peculiar action was first explained by the illustrious John Hunter. It occurs most commonly in those that have died a violent death, such as from hanging, fracture of the skull, &c.; but it is by no means confined to these cases. It will be found (1) That the opening usually exists at the fundus and cardiac, or greater end of the stomach, and probably in the posterior part; but that this will be dependent on the position of the body. (2) That the opening is large and irregular, and the edges pulpy. (3) That the mucous membrane of the stomach is not inflamed. (4) That there is no well marked peritonitis, although some slight action may be noticed, if the gastric fluid has escaped, and come in contact with other organs. (5) That there are no changes in the throat, or gullet. (6) That during life there were no symptoms of poisoning, and that after death no poison can be found on analysis.

(B) *The post-mortem appearances of Irritants.*

They are those of inflammation and its results.

The redness of the stomach may be very slight, the surface being covered with a tenacious glairy secretion. Remember, however, that the stomach is always slightly red during digestion; that there is increased redness if the post-mortem has been delayed for some hours; and that one often finds redness of a very marked degree in diseases where there has been no gastric complaint, or sign of poisoning, as, for example, after death by acute bronchitis, or where brandy has been administered shortly before death. The stomach, too, if the post-mortem is not made for some time after death, may have a yellowish, or greenish appearance from the proximity of the liver.

But the redness after death by irritants will usually be found to be excessive, the coats of the stomach thickened, the submucous tissue loaded with extravasated blood, ulcerated, softened, gangrenous, or, it may be, hard and shrivelled. Up to the end of the duodenum black ramifying vessels and black spots may often be seen, whilst the whole of the small intestines are more or less inflamed, ulcers being sometimes found in the large intestines. Inflammation may often be noticed in the larynx and air passages.

A very important question may arise here—how long after death can you distinguish inflammation, the effects of an irritant poison, from a post-mortem change. This rule is a safe one—*Never allow mere redness of the mucous membrane to be a proof of inflammation;* but if the redness be accompanied with softening and putrefaction, with the deposit of glairy mucus, and with general opacity of the mucous membrane, you may safely conclude that it is so. *Gangrene*, again, may be due to internal constriction, as in cases of hernia. *The injection of vessels with* *black blood* is found in enteritis and acute dysentery, and may be produced by the application of the mineral acids after death. You will know *Melanotic spots* by their being well defined, and by the absence of general inflammation. *Ulcers* (*not* corrosions, for the one is produced by chemical means, whilst the other is strictly vital) may result from poison, or from disease :—

(*a*) *Ulcers from poison* are rare, and generally they are accompanied with extensive inflammation in the small intestines, and especially in the duodenum. They are usually discoloured—the colour depending on the poison from which they result.

(*β*) *Ulcers from disease* will probably be confined to the stomach, other parts being in a tolerably healthy condition. They are generally situated on the posterior surface, or along the lesser curvature, or in the neighbourhood of the pylorus. They are usually round or oval, with a tolerably sharp outline, looking as if they had been punched out, the edges being thickened, raised, and smooth. Those from cancer may sometimes be very ragged.

(C) *The post-mortem appearances of Narcotics and Narcotico-Acrids.*

In poisoning by these substances, very possibly no characteristic post-mortem appearances will be discovered. They are rarely found to inflame the stomach or bowels. In the post-mortems of cases of poisoning by opium, fulness of the veins and sinuses of the brain, with effusion of serum beneath the membranes, at the base, or in the ventricles, with occasional extravasation of blood, are commonly found.

Diseases that simulate Poisoning.

There are many diseases, it must be admitted, that even an experienced medical jurist may confound with poisoning, and hence the extreme necessity for care in such cases in giving opinions. It is not often that any difficulty will be found after a post-mortem has been performed, because if disease has been the cause of death, such disease will probably be discovered.

1. *Diseases that simulate poisoning by Corrosives and Irritants.*

(*a*) *Acute Gastritis*, which rarely, if ever, occurs idiopathically.

(*β*) *English and Asiatic Cholera*, and *all other acute inflammations of the Alimentary Canal, such as Dysentery, &c.*—In cholera the vomit rarely contains blood, which it frequently does in irritant poisoning. In cholera, again, there is rarely pain or constriction in the throat, and if it does occur it is the soreness of vomiting, and is occasioned by it. In cholera, again, purging is an earlier symptom than it is in poisoning. (*See* Dr. Letheby's paper, " Medical Times," Nov. 11, 1848, p. 76.)

(*γ*) In *Ileus, Strangulated Hernia*, &c., we generally have constipation, the vomited matters being fæcal.

(*δ*) *Rupture of Abdominal Viscera.*—The rupture of the stomach during or directly after a meal, from probably an effort to vomit, has been a cause of sudden death. So also aneurism and the rupture of intestines, biliary ducts, uterus, and other viscera, the giving way of the Fallopian tubes, apoplexy of the ovary, &c. (all of which may be accompanied by symptoms of collapse, by pain, vomiting, and death in less than twenty-four hours), have been mistaken for cases of poisoning. The true cause, however, of all these will be revealed by the post-mortem.

(ε) Drinking a draught of cold water when heated has caused sudden death. The absence of poison will be the main evidence in such a case.

2. *Diseases that simulate poisoning by Narcotics, &c.*

We must remember there are many diseases of the nervous centres in which coma and insensibility are prominent symptoms. In uræmic poisoning, apoplexy, epilepsy, hydrocephalus, blows on the head, and sometimes even in fever, similar symptoms occur. Nor must we assert that the diagnosis in such cases is easy, or the post-mortem appearances conclusive.

In *Epilepsy* the history of the case, its chronic nature, the length of the fits, and the peculiarity of the paroxysms, will generally be sufficient to lead to a correct diagnosis.

In *Apoplexy* note (1) the general premonitory symptoms ; (2) that it usually attacks the old ; and (3) that it is often impossible to rouse the patient from the apoplectic sleep.

Whilst in poisoning (1) there are no premonitory symptoms ; (2) any may be the victims, and (3) that with such poisons as *opium* the patient can be roused.

Idiopathic Tetanus, again, is not common. Note these peculiarities, which will enable you to distinguish between it and the tetanus of strychnia.

(A) Idiopathic Tetanus—

(1) Begins with difficult swallowing, and is followed by stiffness of the jaws, and then stiffness of the trunk and extremities.
(2) The symptoms are at the first obscure, and develop gradually.
(3) Opisthotonos does not come on until after several hours, or may be days.
(4) There is rarely any intermission in the symptoms.
(5) Death takes place after several hours or days, or recovery is very slow.

(B) In the Tetanus of Strychnia—

(1) The muscles of the jaw are rarely attacked at first, and may possibly escape altogether.
(2) The symptoms are well marked at the commencement, and reach their full development in a few minutes.
(3) Opisthotonos is a very early symptom.
(4) There are usually intervals of complete intermission.
(5) Death occurs commonly in less than three hours, or else recovery is very rapid.

Again, Tetanus may be caused by other poisons than strychnia, but if so, it will be usually complicated with other symptoms, whilst in strychnia poisoning tetanus is the one prominent symptom. Nor must we forget the tetanoid convulsions of hysteria and epilepsy, although the general history of the case, and the character of the spasms, with their rapid alternations of relaxation and contraction, and the infrequency of a fatal termination, will, as a rule, be sufficient to guide us to a right diagnosis.

Again, a delirium simulating that produced by Belladonna, &c., is often a symptom of febrile diseases, and of other diseases, if accompanied by fever; and, further, the action of intense cold, and also the symptoms of mental disorders in their incipient stage, may simulate alcohol poisoning, although the peculiar odour of the breath in alcoholism will, if well marked, often be a safe and conclusive sign.

False Accusations—Malingering.

Cases at times occur when persons will imagine themselves the victims of attempted poisoning. Such cases are excessively embarrassing, and need adroit management. Two considerations in dealing with them must be clearly before you. *First*—Is there any truth in the story? and, *secondly*, finding the man is the victim of delusion, can he in any way be convinced or pacified? It would not be justifiable to treat in the first instance all startling stories as imaginary, or as the creation of a disordered brain. The patient should be urged quietly, and by degrees, to give a full account of his case, when before very long he will, no doubt, be found to commit himself with undoubted extravagancies. Having discovered that the man is mad, you must not tell him so, but try to convince him, if possible, that he is wrong, or else (and, perhaps, usually this is the only way) admit all he says, and suggest a remedy. A case in illustration may be quoted. Dr. Letheby, a short time back, had a gentleman call upon him, asserting that his relatives were poisoning him with nitrate of silver, which they put into every article of food of which he partook. He requested analyses made of a large number of samples he had from time to time collected. Dr. Letheby began to urge the extreme improbability of such a thing, but he immediately explained the whole matter by saying "that his relations had discovered that metals were good conductors of electricity, and that their intention was to saturate his system with silver, so as to render his body a conductor, and extract from him of a night when he was asleep, by electricity, secrets of which he imagined himself the custodian." The story being clearly the invention of a lunatic, Dr. Letheby entirely succeeded in quieting the man's mind by agreeing with him as to the power of metals to conduct electricity, but assuring him that if he always slept on a sheet of india rubber, which was a non-conductor, it would entirely frustrate the designs of his friends to extract his secrets. The man went away, entirely satisfied with the remedy suggested.

Nor, again, must we forget that cases of malingering may occur. One of the authors has referred, in the London Hospital Reports, to some cases of this kind that came under his own observation (Vol. ii., page 269). When in doubt, do not treat the case lightly—a day or two will generally reveal the facts.

Lastly, in drawing up a report of a case of suspected poisoning, state—

1. The time—day of the month, day of the week, and the hour, in every case.

2. State the facts seriatim, without any technicalities, never indulging in hypotheses, and never using *ifs* and *buts*; but state

   (*a*) Facts of a medical nature.
   (*β*) Facts you have yourself seen and observed.

3. Then draw your conclusions on the facts stated.

   (*a*) Cause of death, in your opinion.
   (*β*) Why you think the death unnatural (or *vice versâ*).

Classification of Poisons.

Great difficulties have been experienced by writers on poisons in the matter of classification. Nor is this to be wondered at, as classifications at best are merely artificial. Classifying poisons according to their effects, Foderé made six classes, viz. :—(1) Astringents; (2) Rubefacients; (3) Corrosives or Escharotics; (4) Narcotico-Acrids; (5) Narcotics; (6) Septics or Putrefacients. This classification was adopted by Paris and Gordon Smith. Orfila and Devergie made four classes, viz :—(1) Irritants; (2) Narcotics; (3) Narcotico-Acrids; and (4) Septics. Taylor and Christison both take the first three of these only, viz :—(1) Irritants; (2) Narcotics; and (3) Narcotico-Acrids; whilst Guerin makes only two classes—(1) Irritants, and (2) Sedatives.

All these classifications of poisons are more or less objectionable, and we therefore propose adopting the more simple, if less scientific plan, of arranging them according to their origin or natural sources, viz :—

(1) Mineral.
(2) Vegetable.
(3) Animal.
(4) Gaseous.

CHAPTER V.

SYSTEMATIC CHEMICAL ANALYSIS.

Before proceeding to describe the method to be adopted in the examination of the contents of a stomach in a case of suspected poisoning, one or two remarks of a general character may not be altogether out of place, inasmuch as in a matter of such grave importance as a trial for murder, every minute detail has peculiar importance. Before commencing your chemical analysis it is most unadvisable, for many reasons, to be hunting about for the various symptoms that manifested themselves during life. If they are brought before you, well and good—but even then be careful not to place too high a value upon them. For first, the guess as to what has been taken is often wrong; and secondly, symptoms are not infallible guides, for irritants have often produced the symptoms of narcotics and narcotics of irritants.

Let your analysis in every case be complete and systematic. Nothing can justify any other method of procedure. For if you confine your experiments to a mere search for a suspected poison, it may not be there at all, and something else may, and you have then lost a portion of your material; and further, more than one poison may be present, the discovery of which may materially aid in clearing up the case. Let every examination, therefore, be part of a general scheme (we are quoting in substance from a paper of Dr. Letheby's) whereby the search for all poisons may be at once accomplished. If this is not done your only alternative is to guess at the poison that is to be sought for, or else to divide your material into as many parts as there are poisons to be found. In the first case, the chemist lends himself to all sorts of idle rumours, to hearsay gossip, and to the chance of being grossly deceived, and, therefore, seriously wrong in his guesses; whilst in his search for some particular thing, which was never present, he uses up his material, and with it, the only means at his disposal for the discovery of crime. Besides which, a proceeding conducted after such a fashion must always prejudice the judgment of the operator, and destroy the confidence of all who are interested in the enquiry, by making it appear that the principles and powers of chemistry are uncertain, that they are greatly subordinate to the other portions of the case, and that they can never be made an independent or primary part of the investigation. In the second case, as we need hardly say, the operator would be adopting the best possible means of ensuring a failure; for if the poison be present in very small quantity, the division of it into many parts would be a certain way of baffling the investigator.

1. When you receive materials for a toxicological analysis, note at the time in writing—

   (*a*) The person from whom you received it.
   (*b*) The date upon which you received it.

(*c*) The place at which it was delivered to you.
(*d*) The number and description of the articles received.
(*e*) The state (*i.e.*, whether securely sealed or not) in which they were handed to you.

2. The materials sent for analysis should be forwarded by hand and not by any public conveyance, and should be delivered to the analyst himself.

3. After they are delivered to you, never allow them out of your sight except under lock and key, no duplicate key being in the possession of a second person.

4. The analysis must throughout be conducted by yourself, and by yourself only.

5. When you open the bottles or jars do not *break* the seals, but *cut them out* unbroken, and preserve them for identification, if necessary, in the witness box.

6. Remembering the volatility of many poisons, let there be no delay in the commencement of the analysis.

7. Always examine the contents of the different bottles or jars separately. Of course, if different viscera be put into the same jar, then there is no object, as a rule, in making separate analyses of the different viscera.

8. The quantities of every solid should be weighed, and of every liquid (such as the contents of the stomach) measured.

9. Never subject the whole of your materials to analysis at first, for you may have an accident, or it may be necessary for further analyses to be made. In examining, say the stomach and its contents, take about one-third (or one-half, if the quantity be small) and seal the remainder down securely, preserving the bottle under lock and key. If you have an accident (which may happen to the most skilful), or if you wish to confirm your results, you will then be able to operate on the half of what you have left, and even then leave sufficient, if the Court sees fit, for a further examination by some other analyst.

10. Take care that the apparatus you employ is thoroughly clean, and only use such re-agents as you have yourself proved to be pure.

11. In testing for a poison always begin by its most characteristic reaction. If one test, however, fails, do not immediately conclude *the absence* of the poison, but try a second test, remembering how trivial circumstances interfere with some reactions. And, further, never be satisfied of the *presence* of a poison by a single reaction, as certainty can only be established by a combination of tests.

12. Never jump to conclusions on the results of your analyses. Suppose, *e.g.*, a piece of clean copper was coated when boiled in a hydrochloric acid solution. Do not say it is mercury, or that it is arsenic, however much it may look like it, until by further experiment you have proved it is so.

13. Reduce your solutions in testing to as concentrated a state as possible, as the reactions with small quantities, when they are diffused through a large bulk of liquid, may escape notice.

14. Note that although we say a given test will give distinct reactions with a minute fraction of a grain of a poison, we do not thereby intend to imply that such a minute quantity can be discovered when present in complex organic mixtures.

15. In all cases, *if possible,* determine the quantity of the poison present. Remember, however, that the chemical evidence is not defective, although the quantity of poison found is less than that required to kill (*vide* page 46).

In examining the stomach, first of all empty the contents into a measure glass, and note the quantity. Then open the stomach, and spread it out on a clean white plate, and note in writing its internal appearance. Now take a large hand magnifying glass, and carefully inspect the surface. In this way you may possibly find pieces of leaves, fruits, seeds, or roots; or adherent powders, such as magnesia, calomel, or arsenious acid; or crystals of oxalic acid, or shining particles of cantharides, or coloured metallic sulphides (such as the yellow sulphide of arsenic, or the orange sulphide of antimony); or you may detect some sooty matter, such as is generally mixed with arsenic when it is sold retail, or blue colouring matters such as are ordinarily found in the various vermin killers; or you may find pieces of lucifer matches and their colouring matters, if these have been the cause of death. Whatever you find, however, let them be carefully preserved. In a similar manner examine the intestines from end to end.

In examining *the contents* of the stomach. Note—

1. The *quantity* by measure.
2. The *odour;*—such poisons as alcohol, chloroform, carbolic acid, hydrocyanic acid, opium, may thus perhaps be detected.
3. The *colour;*—the mineral acids, *e.g.*, are indicated by the contents having a dark, grumous, charred appearance.
4. The *acidity or alkalinity.*
5. The *consistency* and apparent composition. You may be able to say how long before death the person had a meal, and of what that meal consisted. Also in suspected cases of poisoning in children, note the presence or absence of starchy matters, milk, &c.

Systematic Analysis.

We are indebted largely to Dr. Letheby for the following method of systematic analysis in poisoning cases.

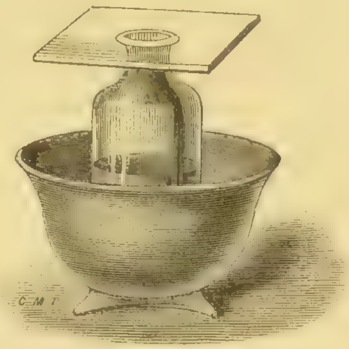
Take one-third of the contents of the stomach, and strain them through a piece of new muslin. Carefully examine the solid materials on the muslin with a hand lens for portions of leaves, seeds, or other bodies that may be present.

We have found it very useful to keep specimens of the seeds of common fruits preserved in little bottles in spirit, so that we may at once be able to compare any seeds found in the stomach with those of known fruits. There will be no difficulty in detecting some of the larger seeds or their coverings, such as those of croton, whilst the smaller seeds, such as those of the poppy, belladonna, hyoscyamus, digitalis, &c., can be easily recognized by their peculiar markings.

And now, having examined the naked eye appearances of the stomach, and its solid contents, mix the whole together in a clean wide-mouthed glass bottle. Stand this in some warm water in a basin, and cover the mouth of the bottle over with a clean glass plate, (fig. 2), upon which a drop of a solution of nitrate of silver has been so placed that it will be freely exposed to the vapours arising from the fluid in the bottle.

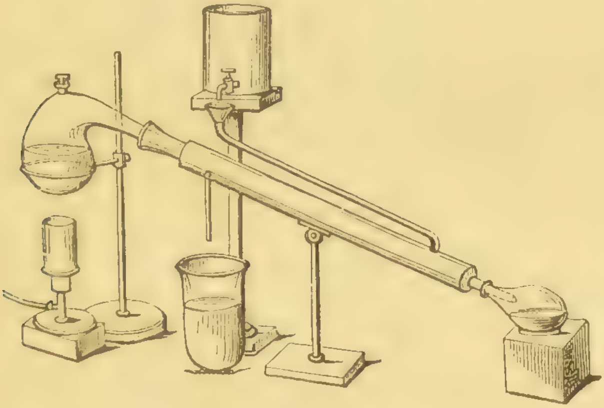
In a very short time, if hydrocyanic acid be present, the drop of silver solution will turn white from the formation of a cyanide of silver. If examined by the microscope, this deposit will probably appear crystalline, the crystals being especially well marked about the edges; but the deposit may not be crystalline, from its admixture with chlorine, bromine, iodine, or their hydrogen acids, and yet be due to hydrocyanic acid. The deposits of argentic bromide or iodide may be known by their not being perfectly white, as well as by the peculiar odour of these bodies, which is readily detected even in small quantities. Cyanide of silver is insoluble in nitric acid at ordinary temperatures, but soluble at a boiling heat; chloride of silver being insoluble in nitric acid, hot or cold.

FIG. 2.



Immediately after the removal of the glass plate with the silver salt, place over the bottle, in a similar manner, another glass, having upon it a drop of a solution of caustic potash; allow this to remain for a short time, and after removing it at once take the bottle out of the water, and put the stopper in. Touch the spot of potash solution with a drop, on a glass rod, of a mixed solution of proto- and persulphate of iron, when, if hydrocyanic acid be present, a brownish green precipitate is produced, which becomes blue (Prussian blue) on the addition of a little dilute sulphuric acid.

FIG. 3.



Liebig's test may, if necessary, also be tried in the same way. (*See Hydrocyanic Acid.*)

Now put the portion of the contents to be examined into a retort connected with a Liebig's condenser and a well-cooled receiver, as arranged in fig. 3, excepting that the retort must, under no circumstances, be exposed to the naked flame, but a salt-water bath must in this, as in every other case, be employed. Distil over about one-sixth of the quantity in the retort. If free hydrocyanic acid be present, it will be found in the distillate. (This is to be tested as directed under *Hydrocyanic Acid.*) If hydrocyanic acid be obtained in this manner, the contents of the stomach *not being alkaline*, the hydrocyanic acid was present in a free state; but if the contents were *alkaline* before distillation, it must have been present in the original liquid as a cyanide, however it may have been administered.

The distillation should now be continued almost to dryness. In the distillate other volatile poisons will be found, and their presence for the most part may easily be detected by their odour, such, *e.g.*, as the volatile oils, alcohol, chloroform, ether, turpentine, carbolic acid, nitro-benzol, benzol, &c. Appropriate tests must then be employed for these. If there is no evidence of any volatile poisons, return or reject the distillate, acidulate the contents of the retort with a few drops of pure sulphuric acid, and once more distil into a small receiver, containing either nitrate of silver or a potash solution, so as to fix any acid that may come over. Any cyanide present will now evolve its cyanogen as hydrocyanic acid. The potash or silver solution may then be tested.

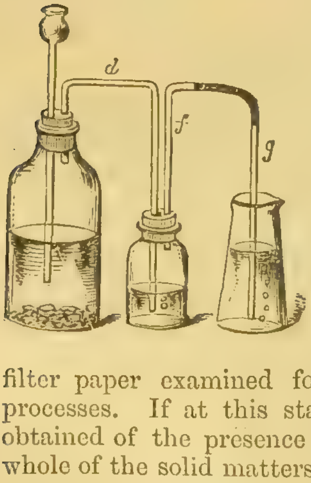
If the contents (already acidulated with pure sulphuric acid) are very thin and watery, it will be advisable to concentrate them to the consistence of a thin paste by evaporation on a water-bath. This is, however, seldom necessary. Treat all the acidulated materials with about twice their bulk of alcohol, and allow the mixture to stand in a warm place for about twelve hours, occasionally giving the bottle a shake.

Filter the liquid through thick blotting paper:

(A) Preserve the solid matters on the filter paper.

(B) Through one-half of the clear filtrate pass a stream of well-washed sulphuretted hydrogen for some short time. (This is conveniently generated in an apparatus represented in fig. 4). If arsenic, or sugar of lead, or corrosive sublimate, or tartar emetic, or any of the metallic chlorides soluble in alcohol are present, a precipitate will be formed, whilst any change of colour produced by a minute trace of metallic salts is best noted by comparing the colour of that portion of the filtrate through which the sulphuretted hydrogen has been passed with that portion unacted upon by the gas. If there is any sign of a precipitate, the gas should then be passed for a considerable time through the whole filtrate. After standing for twenty-four hours, the solution should be filtered, and the precipitate on the filter paper examined for the several metals by approved chemical processes. If at this stage of the examination distinct evidence was obtained of the presence of arsenic, it would be advisable to take the whole of the solid matters and of the liquid contents, mix them with pure hydrochloric acid, and distil them in a retort to dryness, fresh hydrochloric acid being afterwards poured on the materials in the retort and again distilled. By this means you will obtain a clear distillate, containing all the arsenic as a chloride, and rendering the estimation of the

FIG. 4.

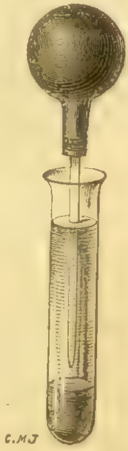


quantity present easy. If no results are obtained by passing sulphuretted hydrogen through the filtrate, allow it to stand for twenty-four hours uncovered, so that the gas may escape. Add now to the whole filtrate an excess of a solution of sub-acetate of lead, and filter.

(C) *The precipitate* contains, besides gummy matters, &c., sulphuric, phosphoric, oxalic and other vegetable acids such as meconic acid, in combination with lead. Diffuse this precipitate through water, and pass sulphuretted hydrogen through it to complete saturation, judging when it is complete by the solution blackening lead paper. Filter off the sulphide of lead formed, and examine the filtrate for the several acids.

(D) Through *the filtrate*, after the precipitate produced by the acetate of lead has been filtered off, pass sulphuretted hydrogen until all the lead which was added in excess is thrown down. This means of getting rid of the lead, although more tedious, is infinitely preferable to any other method. Filter off the lead sulphide, and evaporate the filtrate in a beaker almost to dryness; add to this a drop of acetic acid and about a dram of water, and filter. Evaporate once more the filtrate almost to dryness, add to it a few drops of water, and supersaturate with a solution of pure caustic potash. Put this into a long narrow test tube, and shake it up thoroughly with three or four times its bulk of ether, and allow the whole to stand until the ethereal and watery solutions have completely separated. Very rarely will any difficulty be experienced in this, but if such difficulty occur, and the ether refuses to separate kindly, either try to break down the vesicles of the ether with a glass rod, or else add a little more ether and a little more water. And now carefully decant the colourless ethereal solution. In drawing off the ether we adopt the following plan: Fixed to a pipette of large size we have an elastic india-rubber ball; this we exhaust by pressure before placing the pipette in the fluid. Having pressed out the air, the pipette is to be introduced, care being taken that the end of the pipette does not reach below the ether layer (fig. 5). In this way the whole of the clear ethereal solution will be drawn up into the glass tube as the elastic ball resumes its original state. Again and again, if needful, the aqueous solution must be treated with fresh quantities of ether. Toxicologists differ a little as to the best solvent to be employed. We prefer in the first instance the use of ether, perhaps from the circumstance of being accustomed to it. Most of the organic alkaloids, such as strychnia, brucia, veratria, nicotina, conia, aconitina, atropina, quinia, cantharidin, &c., are taken up by it, whilst its action on some others, such as morphia and cinchonia, is very limited. If therefore after using ether, there were the slightest signs of the presence of morphia or of some other bodies, chloroform should then be used for their more perfect extraction. It is most important that we should familiarize ourselves with the taste of certain alkaloids, such as the bitter of strychnia, as so much may be learnt during the progress of an investigation by the taste of residues. The application, too, of a minute portion of a residue to the inside of the gums, enables us to decide better than by any chemical tests, the presence or absence of such bodies as cantharidin, aconite, &c. Such a method of investigation should never be neglected.

FIG. 5.



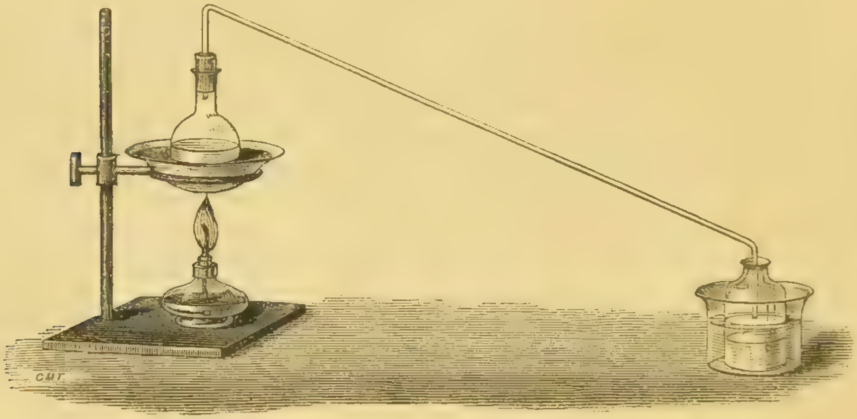
(E) Put the clear ethereal solution into a small flask fitted with a long tube and connected with a receiver kept perfectly cold, and apply a gentle heat, collecting and saving the ether that distils over (fig. 6).

(F) The residue in the flask should now be dissolved out with a little dilute acetic acid, and filtered if turbid, so as to separate any fatty matters that may be left. The residue from this will, in many cases, be sufficiently pure to allow us at once to apply our tests, but if not, it must once more be treated with potash, and the alkaloids again taken up with ether.

The ethereal residue must now be examined for the alkaloids by the various tests to be hereafter described.

It must be borne in mind that the action of the colour tests (as in testing for strychnia), is considerably interfered with by the presence of such a body as piperine, and by spices that are not unlikely to be present in the stomach. To get rid of these impediments to the test, treat the ethereal residue with a few drops of pure concentrated sulphuric acid, and allow the mixture to stand for twelve hours in a warm place. The strychnia is not injured by the acid in the least degree, but the other organic substances will be charred. Dilute with water, supersaturate with potassic carbonate, and again treat with ether, when the pure alkaloid may be obtained.

FIG. 6.



Supposing that no reaction is produced with the colour tests, it is always advisable to try the effects of the residue on a frog in the manner described under *Strychnia.*

(G) Now take all the solid contents left on filter-paper A, cut up the stomach itself, and any other solid matters to be examined, into very small pieces, bruise them in a mortar, place them in a large flask, add to them a mixture of two parts of water and one part of pure hydrochloric acid, and slowly, and by degrees, bring the mixture up to the boiling point. Do not, however, let it boil fast, or for more than a few minutes, and afterwards set it aside to cool; and when sufficiently cold, filter.

(H) Preserve the materials on the filter-paper.

I. To the clear filtrate placed in a glass flask add one or two small pieces ($1\frac{1}{2}$ in. × $\frac{1}{4}$ in.) of *pure* copper-foil; the copper should be thoroughly cleansed, first by igniting it in a Bunsen burner, then acting upon it for a minute with nitric acid, and afterwards thoroughly washing with water. In this way the copper will be rendered perfectly bright, and after cleaning, should not be touched with the fingers. Introduce the copper-foil into the clear hydrochloric acid solution, and boil. If the copper becomes coated, then add fresh pieces of copper, piece by piece, until there is no longer any perceptible discoloration of the last piece that was added. Now remove the pieces of copper, and having washed and dried them between folds of bibulous paper, examine the deposit, whatever it may be (mercury, arsenic, antimony, &c.), by the appropriate tests, hereafter described.

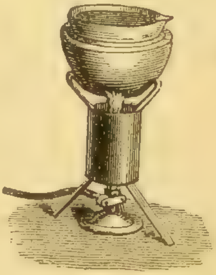
K. Take all the materials left on the filter-paper H, and incinerate them in a Berlin porcelain crucible. Act on the residue with nitric acid, and having diluted with water, filter, and pass sulphuretted hydrogen through the filtrate. In this way any lead, or other substances not dissolved out by other means, will be discovered.

Up to this point we have chiefly spoken of the examination of the stomach and its contents. It will be noticed, however, that precisely the same process may be adopted, with some slight modifications, when examining the tissues. They should be cut up very fine, and, as far as possible, broken up in a mortar into a pulpy mass. Digest them for some hours in spirit and water, acidulated with hydrochloric acid, and proceed as with the contents of the stomach.

Although we are strongly of opinion that the process just described is the one most generally applicable, still, under some circumstances, we admit that it may be desirable to search for the alkaloids before proceeding with our examination for the metals.

The following plan in such a case is the one adopted by the authors:—Having examined the stomach and its contents for volatile poisons, in the manner already described, and also, if necessary, for phosphorus, acidify in slight excess, with acetic acid, which has the advantage of forming very soluble salts with the alkaloids. Evaporate to dryness over a water-bath (fig. 7). In this way any blood in a great measure will be broken up. The residue should now be boiled, first with water acidified with acetic acid, and filtered; and then with alcohol acidified with acetic acid, and filtered. The filtrates should then be mixed together, and set on one side to cool, when any fatty matters that may collect on the surface can be without difficulty removed.

FIG. 7.



Evaporate the liquid to dryness at a low temperature, collecting and preserving the spirit that distils over. If fatty or insoluble matters separate during the distillation, they must be got rid of by filtration.

Dissolve the residue in a little pure water, and add to it a slight excess of bicarbonate of potash. Warm gently. When cold, shake up with ether or chloroform, and proceed as already directed in the last process. This process was that originally suggested by Stas.

Now collect all the materials that are on the filter-papers together, and cut up such solid tissues as you may have to examine into very small pieces, and test them for mineral poisons. For this purpose we strongly recommend the process of Reinsch; that is, the heating all the materials with a mixture of one part of hydrochloric acid, and two of water, filtering, and then boiling, with some pieces of pure copper-foil, in the manner already described.

It is right, however, that we should give here in detail the process of Fresenius and Von Babo for the destruction of the organic matters—a process which, although it has been favourably received by many, is one which we are convinced is neither a desirable nor advisable one for use in practical investigations.

Fresenius's process is as follows:—Put the materials to be examined into a large porcelain dish, and add to them about an equal weight of hydrochloric acid and a little water, so as to make the whole into a thin paste. This must be heated on a water-bath. Add to the hot liquid about thirty grains of powdered chlorate of potash. Stir the mixture frequently, and from time to time continue the addition of the chlorate, until the mass becomes of a light yellow homogeneous character, adding now and then a little water, to make up for loss by evaporation. Continue to apply heat until the liquid ceases to give off any odour of chlorine. When cold, strain the liquid through linen. Wash the solid residue with hot water, and evaporate down the whole of the filtrate to a small bulk, and again filter.

The next part of the process is to reduce any metallic oxide that may be in solution, and which will be present as a high oxide, to a lower grade of oxidation by heating with sulphite of soda. This being done, sulphuretted hydrogen is to be passed through the solution, and the steps of an ordinary systematic analysis is then all that is necessary.

We must just refer to one other process, viz., that suggested by Flandin, of breaking up the organic matters with heat and sulphuric acid.

We are conscious that possibly some will object to the use of subacetate of lead in the process we have recommended; but inasmuch as the lead is not to be added until we have entirely completed our search for metallic poisons, we are of opinion that such objections are immaterial.

Further, considering that the verdict of a jury, and consequently the life or death of a prisoner is frequently dependent on a chemical analysis, the results we obtain by our tests should in all cases be something more than questionable or doubtful reactions, about which a possible difference of opinion may exist. We consider it, therefore, unnecessary to enter into any descriptive detail, as others have done, of processes for the detection of millionths of a grain by such methods as the collection of microscopic sublimates, which we admit are as exquisitely beautiful, as they are, in our opinion, totally unfitted for practical investigations. If such poisons as arsenic, calomel, tartar emetic, corrosive sublimate, and oxalic acid, cannot be detected by their reactions in a test-glass, we are doubtful whether we should ever be justified in giving positive evidence of their presence on a criminal trial, by their microscopic form, and microscopic reactions. These are all very well as confirmatory tests, but nothing more. To build evidence entirely upon them in a criminal case is dangerous in the extreme.

Lastly, although we have given a detailed account of methods of systematic analyses, such as we ourselves adopt in toxicological investigations, it would not be fair to conclude this chapter without warning the operator that he must be prepared at every turn to encounter numerous difficulties, which are as impossible to be described as they are unexpected, and the remedies for which can alone be suggested by his own chemical knowledge and manipulative skill. (For Experiments on Dialysis in Toxicological Enquiries, see "Medical Times and Gazette," Dec. 12, 1863, p. 611.)

CHAPTER VI.

MINERAL POISONS.

PHOSPHORUS.

Varieties—Circumstances affecting its luminosity—Solubility—Symptoms, &c. of Poisoning—Treatment—Post-mortem Appearances—Chronic Poisoning—The Lucifer Disease—Precautionary Measures—Tests—Toxicological Analysis—Cases of Poisoning.

(P = 31. Sp. gr. of vapour, 4·42; boils at 288° C.; fuses at 44° C.; takes fire at about 60° C.)

Phosphorus assumes different allotropic forms, of which, amongst others, are the following:—

1. *Clear transparent variety.*—This is yellow, soft, wax-like, and tasteless in the solid form, but has a sharp, pungent flavour in solution. It has the odour of garlic. The sp. gr. varies from 1·848 to 1·853. It is a non-conductor of heat. It volatilises at 44° C., the fumes in a dark room appearing luminous.

2. *White opaque variety* (Rose).—This is formed by the action of light on the yellow phosphorus when kept under water. The white opaque crust forms most readily when the water contains an abundance of calcareous matter. Sp. gr. is 1·515.

3. *Black variety* (Thénard) is produced when ordinary phosphorus is melted and suddenly cooled to 0° C.

4. *Red variety* (Schrötter) is formed by heating yellow phosphorus for thirty or forty hours in an atmosphere in which it cannot oxidise, and at a temperature of from 238° C. to 248° C. It is amorphous, and of a dull red colour. Its sp. gr. is 2·14, and it fuses at 288° C. It is not luminous until heated to near its firing point (316° C.). It is insoluble in bisulphide of carbon. It becomes changed back again to the common yellow variety by the action of heat in the presence of air.

Phosphorus has a great affinity for oxygen. It sometimes ignites spontaneously, and particularly if it be in a finely divided state, or smeared with a little olive oil.

Circumstances affecting the Oxidation of Phosphorus in Air.

(*a*) *Temperature.*

It ceases to be luminous at 0° C.; it becomes faintly luminous from 5° to 6° C., the luminosity above this being in direct ratio to the heat applied.

(β) *Pressure of surrounding Atmosphere.*

The luminosity is increased by a rarefied atmosphere, and checked by a dense one. At a pressure of four atmospheres (60 lbs.) scarcely any luminosity will be apparent even when the phosphorus is liquefied and partially sublimed.

(γ) *The presence of certain Vapours and Gases.*

The following diminish, or altogether prevent, the luminosity of phosphorus but their exact action is doubtful: pure dry oxygen, impure hydrogen, bromine, chlorine, iodine, sulphurous acid, nitrous acid, nitric oxide, phosphoretted and sulphuretted hydrogen, ether, alcohol, bisulphide of carbon, olefiant gas, coal gas, naphtha, turpentine, volatile oils, &c.

The following have no apparent action: pure hydrogen, nitrogen, carbonic acid, carbonic oxide, hydrochloric acid, ammonia, sulphur vapour, sulphuric acid, acetic acid, &c.

Proportions in which certain Gases and Vapours stop the slow Combustion of Phosphorus in air at ordinary Temperatures and Pressures.

Name of the Gas.	Proportions in the air by volume.	Temperature when the luminosity ceases. Centigrade.
Sulphuretted Hydrogen.	$\frac{1}{5}$	18·9
Sulphurous Acid	$\frac{1}{11}$	7·2
Chlorine	$\frac{1}{12}$	12·2
Ditto	$\frac{1}{25}$	18·8
Ether	$\frac{1}{150}$	18·8
Olefiant	$\frac{1}{450}$	18·8
Phosphoretted Hydrogen	$\frac{1}{1000}$	18·8
Naphtha	$\frac{1}{1820}$	18·8
Oil of Turpentine	$\frac{1}{4444}$	18·8
Bisulphide of Carbon	Merest trace.	36·1

Quantities of Vapour required to check the Luminosity of Phosphorus in air at elevated Temperatures.

Gas, or Vapour.	Proportions in the air by volume.	Temperature at which Oxidation ceases.
Olefiant Gas	$\frac{1}{2}$	93·3 Cent.
Ether	$\frac{1}{2}$	101·2 ,,
Ditto	$\frac{2}{3}$	104·4 ,,
Naphtha...	$\frac{1}{112}$ [*]	76·6 ,,
Turpentine	$\frac{1}{156}$ [*]	85·5 ,,

The white fumes evolved when phosphorus undergoes slow combustion in air are chiefly phosphorous anhydride with some phosphoric anhydride. Ozone is also produced, as may be proved by the action of the vapour on a solution of starch and iodide of potassium. When the combustion is rapid, phosphoric anhydride (P_2O_5) is formed; and if this is allowed to collect on neighbouring objects, it prevents their taking fire. Hence, phosphorus flames do not spread.

Burns of the skin of great severity are caused by phosphorus. These are due to two causes: (1) the great heat produced by its combustion, and (2) the development of phosphoric acid, which is a powerful local irritant. Alkaline lotions form the appropriate treatment in burns of this character. The solubility of phosphorus in different liquids is represented in the following table :—

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[*] With a large amount of naphtha and turpentine, phosphorus may be actually distilled without firing.

Solubility of Phosphorus in various Liquids.

Water	Slight.
Strong Acetic Acid . .	0·04 per cent.
Alcohol (sp. gr. 834) . .	0·4 ,,
Ether (sp. gr. 758) . .	0·9 ,,
Olive Oil (sp. gr. 916) . .	1·0 ,,
Turpentine (sp. gr. 996) .	2·5 ,,
Bisulphide of Carbon . .	10 to 15 times its weight.

The solutions, however, differ in strength very materially, according to the length of time that the solvent has acted.

Table showing the Solubility of Phosphorus in various Liquids after remaining in contact with them for different times.

Liquid.	Quantity by Measure.		Quantity by Weight.	Amount of Phosphorus taken up during					
				1st day.	2nd day.	3rd day.	4th day.	5th day.	6th day.
Alcohol ...	1 oz.	=	400 grs.	0·31	0·4 2	0·54	0·96	1·5	1·6
Ether ...	1 oz.	=	364 ,,	2·9	3·0	3·1	3·3	3·3	3·3
Olive oil ...	1 oz.	=	440 ,,	1·0	1·3	2·4	3·0	4·0	4·4
Turpentine...	1 oz.	=	478 ,,	3·1	4·8	6·5	8·6	10·0	12·0

Phosphorus is neither acted upon by sulphuric acid at ordinary temperatures, nor by boiling hydrochloric acid, nor by solutions of ammonia, alkaline carbonates, sulphates, or phosphates, nor by solutions of sugar, albumen, or gelatine, nor by infusion of tea, nor by tincture of galls, milk, bile, &c. It is acted upon, more or less, by sulphuric acid at 93° C., by nitric and iodic acids, by some organic acids (as acetic), and by solutions of caustic, soda, and potash. It combines readily with nascent hydrogen. It exerts a powerful reducing action on many metallic solutions, such as those of gold, silver, copper, and platinum, whilst it possesses, apparently, no action on lead, iron, zinc, antimony, arsenic, or manganese. It has no action on dead mucous membrane, unless freely exposed to the air, when it softens, discolours, and in time dissolves it.

Phosphorus is frequently used on the Continent, but comparatively rarely in this country, for criminal purposes. The various forms of rat-paste, which contain generally about 5 per cent. of phosphorus, mixed with flour, sugar, oil, butter, and Prussian blue, and lucifer-match tips, which consist of phosphorus, chlorate of potash, sand, and some colouring-matter have been the usual forms in which the poison has been taken.*

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* Composition of rat-paste : 8 parts of phosphorus are liquefied in 180 parts of lukewarm water, and poured into a mortar ; 180 parts of rye-meal are added, and, when cold, mixed with 125 parts of sugar, 180 parts of butter, and some colouring matter. Roth and Ringeisen's rat poison is composed of phosphorus and arsenic. It has caused death ("Medical Times and Gazette," Dec. 1, 1855, p .560

Symptoms, Dose, &c.

The symptoms vary considerably as to the time of their commencement. Sometimes they set in rapidly, but more often a considerable interval occurs before any serious effects are noticed. Even a period of inaction as long as five days is recorded. As a rule, within one or two hours the patient complains of a peculiarly disagreeable taste, and of extreme warmth in the stomach and bowels, gradually developing into a violent burning pain. Phosphorescent eructations, having a garlic-odour, may be observed. Vomiting and purging are not unfrequent, the vomit being generally dark-coloured, and having the peculiar phosphorus odour. The pulse is weak, the temperature low, the pupils dilated, the thirst intense, the abdomen distended, the extremities cold, and the intellect clear.

For a time the patient will probably rally, and be apparently fast recovering, when, about the third to the fifth day, jaundice, with retention of urine, and possibly delirium, will set in. In twelve out of sixteen cases jaundice is recorded. The relapse is usually sudden, and the patient will, in all probability, die within forty-eight hours from its occurrence, either comatose or in convulsions. In one or two cases paralysis has occurred, the action of the poison on the nervous and genital system being generally well marked. Recovery is comparatively very rare.

The time of death varies. One case is recorded where it occurred in half-an-hour, one in thirteen hours, one in twenty hours, and several other cases in times varying from two to twelve days; from the third to the seventh day being the most common.

The quantity necessary to destroy life may be judged of from the following cases. A child died after sucking two matches, or a quantity equal to about the one-fiftieth of a grain; one-eighth of a grain killed a woman, and 1·5 grains a man, in twelve hours. On the other hand, Dr. Wormley records a case of recovery after a child had swallowed a teaspoonful of phosphorus paste, and Dr. Taylor one of recovery after a child had sucked three hundred matches. The authors have found 0·5 grain of phosphorus will kill a dog. Dr. Pereira asserts that Chabert, the celebrated "Fire King," could swallow sixteen grains of phosphorus without inconvenience (!!).

Treatment.

The treatment is comparatively simple, for there is no chemical antidote for the poison. To get it out of the stomach therefore, as soon as possible, is the one great indication. If the patient is seen soon after the poison has been taken, the stomach-pump may be used; otherwise, an emetic of sulphate of zinc is best. Some thick diluent, such as magnesia or chalk, mixed in gruel, should be freely administered, in order both to suspend the fragments of the poison, thus protecting them from oxidation as well as to neutralise their acid products. Alkaline drinks may be given freely; whilst, if the poison has had time to reach the intestines, a free purge should be administered. But note particularly that *no oil or fatty matters must be given*, for they dissolve phosphorus, and so aid its absorption.

M. Perronne strongly recommends turpentine in cases of phosphorus as well as in pyrogallic acid poisoning. His experiments have been repeated and confirmed by Köhler and Schimpf. ("British Medical Journal," February 4, 1871, p. 123; "St. Andrews Med. G. Trans.," vol. v., p. 53.)

Animal charcoal has been also recommended, from its power of absorbing free phosphorus. (Eulenberg and Vohl.)

Transfusion of blood is recommended if the case becomes desperate. The experiments of Drs. Eulenberg and Landois seem to show that, even in extreme cases, life may by this means be prolonged. ("British Medical Journal," July 27, 1867, p. 71.)

Professor Bellini ("British and Foreign Medical-Chirurgical Review," 1870, p. 25), in a valuable paper on antidotes to phosphorus, speaks favourably of the nitrate of silver. Three grains of nitrate of silver are necessary for the neutralization of one of phosphorus. Phosphorus in the presence of nitric acid and oxide of silver, produces an insoluble compound of silver and phosphorus, which is unaffected by weak acids or by the acids of the stomach.

Physiological Action.

The physiological action of phosphorus as a poison has been a subject of some discussion, and may be considered here. Some hold that its poisonous action is due to its conversion into phosphorous acid, the oxidation being effected at the expense of the oxygen of the blood. With this view, it has been recommended that all the water that is used in making the mucilaginous drinks in which to suspend the magnesia or chalk, or even the water that is given to relieve thirst, should be boiled, in order to get rid of the dissolved oxygen. Similarly, Perronne's explanation of the action of turpentine as an antidote, is its power of preventing internal combustion. On the other hand, it is held that phosphorus is a true blood-poison, capable of being absorbed, and remaining unaltered even after absorption. The fact that the urine in poisoning by phosphorus has more than once been noticed to be luminous, somewhat confirms this view. And hence the exactly opposite line of treatment has been suggested. Dr. Percy ("Prize Essay," 1872) advocates turpentine as an antidote, but states that the old oil only is antidotal, accounting for the circumstance by the fact that the old oil has already absorbed oxygen. He even urges, as of great service, inhalations of oxygen, and the gradual introduction into the stomach, by means of an elastic tube, of highly oxygenated water.

Post-Mortem Appearances.

The appearances usually found after death are those of a corrosive irritant poison, but they are somewhat variable, the variations being largely dependent on the form in which the poison was taken. In some cases no special morbid appearances have been noted.

The skin usually has a peculiar yellow icteric appearance. On opening the abdomen, black spots or patches may be observed, and, possibly, luminosity of the stomach or other parts will be apparent. The stomach and intestines will usually be found inflamed, and occasionally gangrenous, here and there marked with either large or small ecchymosed patches, some being apparently in a state of ulceration. Small vesications of the mucous membrane are recorded. Perforation of the stomach has been noticed. Black spots and patches are also commonly found both on the skin and on the pleura and pericardium. The mesenteric glands are usually found to be very soft, and to break down with the merest touch. Blood is often found in the bladder, intestines, and pleural cavity. The mucous membranes throughout the entire body are generally discoloured and softened. The heart is usually discoloured, empty, and contracted, but sometimes will be found to contain a small quantity of fluid blood. The blood is commonly dark, and, although fluid, syrupy in consistence. In phosphorus poisoning the blood corpuscles are said to undergo complete disintegration. (Dr. Percy.)

It has been stated that the acute yellow atrophy of primiparous single women is generally due to phosphorus poisoning.

One singularly uniform post-mortem appearance is the fatty change discoverable in the liver, and sometimes accompanied with atrophy, as well as in other soft organs, such as the kidneys, the glands of the stomach, the heart, the muscles, and, at times, the aorta. This fatty degeneration produced by phosphorus was first noticed by Dr. Lewin, of Berlin. His experiments on dogs were entirely confirmatory of the records of autopsies. However emaciated the animal, Dr. Lewin found fatty degeneration a constant after-death appearance of poisoning by phosphorus. No doubt this fat is produced by the decomposition of the albumen in the viscera. ("British Medical Journal," Dec. 26, 1863, p. 690.) These facts have been further investigated by Voit and Bauer, who found similar fatty changes produced by phosphorus in dogs that had been previously starved. We must, however, remember that fatty degeneration is occasionally found, although in a much less degree, in cases of poisoning by other substances, such as ammonia, alcohol, &c. Lewin further noticed that phosphorus produced a peculiar affection of the kidneys, and that, during life, in these cases, the urine was generally albuminous. The urea excreted seems to be increased, whilst the oxygen taken in, and the carbonic acid given off, is said to be lessened.

Chronic Phosphorus Poisoning.

The Lucifer Disease.

This disease was first investigated by Lorindser of Wieden (1845), and afterwards by Heyfelder (Nurenburg), Strohl (Strasbourg), Dupasquier (Lyons), Helft (Berlin), Roussel (Paris), Von Bibra and Geist (Nurenburg), Taylor (Nottingham), Letheby, Simon, and Stanley (London). (See "Lancet," Vol. I., 1850, p. 41.)

The lucifer-disease specially attacks weakly, scrofulous subjects engaged in either the dipping, the drying, or the packing the matches.

In the manufacture of lucifer-matches the wooden splinters are first coated with some material to render them easy of ignition, such as sulphur or paraffin. They are then dipped on a *warm* iron-plate coated with a phosphorus composition, consisting of chlorate of potash, gum, glue, phosphorus, and some colouring-matter. During this process, supposing even that the phosphorus composition does not fire (which is no uncommon thing), a quantity of acid fumes are continually evolved.

The matches are then dried, and here again the evolution of the deleterious phosphorus oxides continues.

The evil effects of these vapours are rarely immediate, although occasionally bronchial and gastric discomfort will be complained of very soon after commencing work. In one case recorded by Pluskal, it occurred after a very slight exposure. But more often months, and sometimes even years, will elapse before any symptoms of illness arise. Cases where 2½ years (Stanley), 3½ years (Geist), 6 years (Dr. Taylor), and even 12 years (Taylor and Simon), are recorded. The first thing complained of will probably be increasing weakness and fatigue, with griping pains in the abdomen, and diarrhœa. After a time an intermittent toothache will torment the patient. The teeth on examination will be found to be carious, the gums swollen, and daily more and more retiring from the teeth, with possibly pus of an offensive nature issuing from them. Possibly the glands of the neck will appear more or less inflamed. After a time the jaw becomes exposed, and will be found rough and diseased. The general system usually suffers severely, and unless the bone exfoliates, or is removed by operation, death is almost certain. The length of time the disease lasts, varies. In some cases it is only a few weeks, whilst in others it torments the patient for years.

In the majority of the cases the lower jaw is the seat of the disease. In Dr. Lorindser's 22 cases, 9 were affected in the upper jaw, 12 in the lower, and 1 in both. In 15 cases recorded by Von Bibra and Geist, 5 were in the upper jaw, 9 in the lower, and 1 in both. In the 8 cases of Neuman's, 3 were in the upper, 4 in the lower, and 1 in both. Of the 54 cases recorded, therefore—

27 were in the lower jaw.
22 were in the upper jaw.
5 were in both.

As to the *cause* of the disease, both Dupasquier and Stanley were of opinion that it depended on the contamination of the phosphorus that was used with arsenic, whilst most investigators consider that the effects are produced by the irritating fumes of the phosphorus oxides, and possibly by the ozone. The action, it is generally believed, is in the first instance merely local. It is a well-known fact that the disease does not occur until one or more of the patient's teeth have become carious. The periosteum thus exposed is acted upon by the saliva in which the acid fumes are dissolved. And this is no doubt the reason, the saliva being brought into contact with the lower jaw by gravitation, why it is generally affected. But the action, although local, is more than local—the sallow look, the gastric disturbance, the nervous irritability, the eruption on the skin, the falling off of the hair, the frequent occurrence of tubercular deposit, the black condition of the blood, and the enormous increase of phosphates in the urine, indicate that the action is due to the actual absorption of the poison into the system.

It has been noticed further that women who work in phosphorus manufactories very often miscarry. ("Lancet," Oct. 16, 1858.)

The following precautionary measures should be recommended :—

1. *Cleanliness.* Before leaving the factory the clothes should be changed, and the hands and face washed in a slightly alkaline liquid.

2. *Alkaline Drinks* should be provided, and the mouth at times rinsed out with a weak solution of carbonate of soda.

3. The workshop should be *well ventilated*, which is best effected by the introduction of several large shafts.

4. The "*dipping*" process should be done in a separate room, so as to expose as few of the workpeople as possible to the fumes.

5. *Saucers full of turpentine* should be placed about the factory, so that the vapour may be thoroughly diffused throughout the room. The action of hydro-carbons has been already alluded to.

6. The evil may be entirely remedied by the use of the *red phosphorus* instead of the yellow phosphorus in match-making.

Tests for Phosphorus.

1. *Its odour.*—This can be recognised in exceedingly dilute solutions.

2. *Its property of fuming in the air and shining in the dark.*—These effects only become manifest when the phosphorus is examined in the dry state, or in solution in water, vinegar, or the fixed oils, the effects being intensified by the application of heat. It is not manifest when the phosphorus is dissolved in ether, bisulphide of carbon, alcohol, turpentine, or the volatile oils, until the solvent has completely evaporated.

The criminal admixture of phosphorus with food has more than once been discovered by its luminosity. ("Ann. d'Hygiene," 1870, 2, 203.)

3. *Its faculty of evolving ozone, &c., in damp air.*—This may be known by

(α) A solution of nitrate of silver on white paper being blackened.
(β) Starch and iodide of potassium on white paper being turned blue.
(γ) Litmus paper being first reddened and then bleached.
(δ) The protosalts of manganese being discoloured.

4. *The colour of the flame and the products of its combustion.*—It gives a bright yellow light when burnt, and produces a white smoke. (Phosphoric anhydride.)

5. *Its action on certain metallic compounds.*

(α) Solid phosphorus reduces gold, silver, copper, &c., from their solutions.
(β) *Nitrate of silver* gives a *black* precipitate, with a solution of phosphorus; *sulphate of copper* a brown precipitate; and *mercuric chloride* a yellow precipitate.

6. *Its conversion into Phosphoric Acid.*

To effect this proceed as follows:—

Boil the phosphorus in a retort with twelve or fourteen times its weight of dilute nitric acid (sp. gr. 1200). The materials that distil over must be poured back into the retort from time to time, until the whole of the phosphorus be dissolved. Evaporate the solution nearly to dryness, and dissolve the residual phosphoric acid in water. The solution is acid to litmus paper.

A solution boiled for some time, and just rendered neutral with ammonia, gives—

(α) With *nitrate of silver* a yellow precipitate ($Ag\ PO_4$), or, under some circumstances, a white precipitate ($Ag\ PO_3$).

(A yellow precipitate is also produced by nitrate of silver with neutral solutions of arsenious acid, but the precipitate is crystalline, and when heated in a reduction tube yields a sublimate of octahedral crystals of arsenious acid.)

(β) *Ammonia and Sulphate of Magnesia.*

Produce a white precipitate of ammonio-magnesic phosphate

$$(H_4 N, Mg PO_4 + 6 H_2 O),$$

soluble in free acids. Collect and wash the precipitate. Dry, ignite, and weigh ($= Mg_2 P_2 O_7$).

100 grains = 28 grains of free phosphorus.

(A similar precipitate is produced with arsenic acid, and is soluble in acetic acid. It may be known from the phosphoric acid solution by nitrate of silver giving a reddish brown precipitate with arsenic acid, and a yellow precipitate with phosphoric acid.)

(γ) *Molybdate of Ammonia* (*Sonnenschein*).

(The test is prepared by dissolving 1 part of molybdic acid in 8 parts of ammonia solution, and 20 parts of nitric acid.)

A yellow precipitate of phospho-molybdate of ammonia is produced.

Toxicological Analysis.

In conducting a toxicological examination, it must be remembered that free phosphorus will probably not be found if the patient has survived for several days, or even if the examination be long delayed after death. In one case where a girl died six days after taking the poison, and in another where after death 23 days had passed before the analysis was commenced, no signs of phosphorus were found.

(1) Note the odour—whether it is like garlic or not. Remember that the smell of phosphorus may be obscured by other highly odorous bodies.

(2) Examine as to the presence or absence of luminosity. If white fumes are evolved note their action on pieces of white paper moistened either with nitrate of silver or with starch and iodide of potassium (page 75).

(3) Pour the contents of the stomach out into a very shallow vessel, and spread the more solid portions in a thin layer on a plate. In this way any particles of phosphorus, however minute, will be detected by their appearing luminous. Always examine the materials in a *dark* room, so that the luminosity may be better seen. If you find pieces of phosphorus, weigh and preserve them in water.

(4) Carefully search for any fatty matters that may contain phosphorus.

(5) Carefully examine the stomach and alimentary canal for pieces of lucifer matches, and for such colouring matters as Prussian blue, &c., that are used both in their manufacture, and in that of rat pastes.

(6) Several methods of detecting phosphorus in organic solutions have been proposed.

I. (Method of Lipowitz).

This depends on the property possessed by sulphur of combining with free phosphorus when heated with it.

The contents of the stomach are to be acidulated with sulphuric acid. Small lumps of sulphur about the size of a bean are then to be put into a retort with the acid contents, heat applied, and the distillate collected. Boil for at least one hour.

A. *Remove and wash the pieces of sulphur.*

(1) Note their odour—whether like garlic or not.

(2) Note whether they appear luminous in the dark.

(3) Heat them with strong nitric acid, and evaporate the liquid to a small bulk ; neutralise with ammonia, and estimate the phosphoric acid present by adding sulphate of magnesia, collecting, drying, igniting, and weighing the precipitate ($Mg_2 P_2 O_7$).

B. *Examine the distillate similarly for phosphoric acid.*

Lipowitz states that by this method he could detect one part of phosphorus in 140,000 parts of an organic liquid. We have not ourselves been able to obtain satisfactory results with so small a quantity as this, although we believe the method is reliable.

II. (Method of Dusart and Fresenius.)

This process depends on the power of nascent hydrogen to combine with phosphorus to form phosphoretted hydrogen (PH_3), which in the dark is luminous, and sometimes inflammable.

Hydrogen is to be set free by the action of dilute sulphuric acid on zinc, and the organic mixture containing the phosphorus cautiously added.

Note—

(α) The flame produced when the gas is burnt at the jet is of an emerald green colour.

(β) The gas gives *a black precipitate* when passed into a solution of nitrate of silver.

(γ) It gives a *black precipitate* passed into a solution of chloride of mercury.

III. (Method of Mitscherlich.)

The organic liquid is to be distilled in the dark, with a little dilute sulphuric acid, which neutralizes any ammonia generated during putrefaction, and the vapours conducted through a tube kept well cooled with running water, and the end of which passes into a receiver (Fig. 8). The phosphorus vapour will condense in the tube, and will be there seen to be luminous. The distillation must be carried to dryness.

Note the results in this experiment as follows :—

1. The luminosity of the vapour in the tube.
2. The garlic odour of the distillate.
3. Examine the distillate for minute globules of phosphorus.
4. Treat the distillate with about two drams of nitric acid. Concentrate to a small bulk, and estimate the phosphorus by adding ammonia and sulphate of magnesia.
5. Lastly, drench what remains in the flask with its own bulk of dilute nitro-hydrochloric acid (1 part of nitric, 2 of hydrochloric, and 4 of water), and distil to dryness. The distillate, with a few drops of

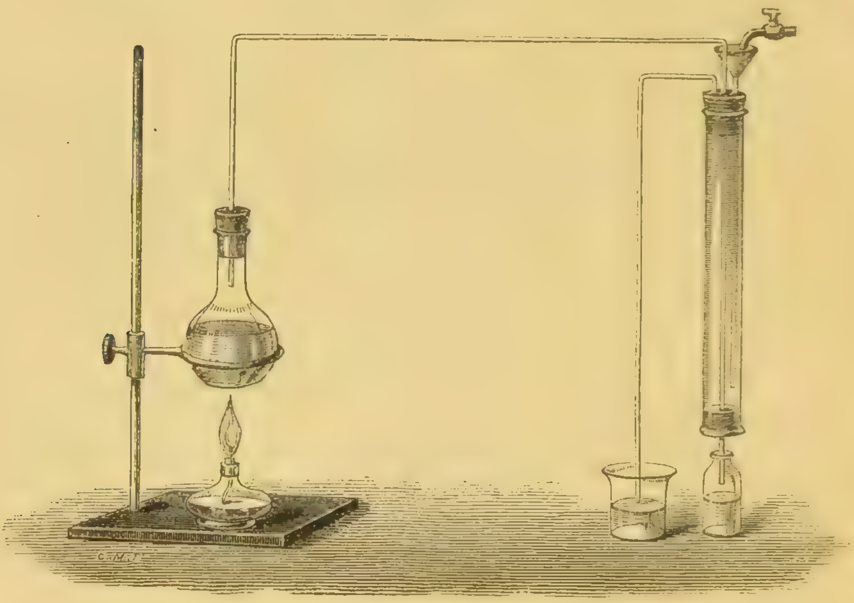
nitric acid, is to be evaporated to a small bulk, and the phosphoric acid estimated by the addition of ammonia in excess, and sulphate of magnesia as already described, drying, igniting, and weighing the precipitate of pyrophosphate of magnesia.

We have obtained excellent results by this method with less than $\frac{1}{50}$th of a grain of phosphorus in 5 ozs. of organic liquid. If phosphorescence is noticed it is decisive of the presence of *free* phosphorus. Unless phosphorescence is noted, or globules of phosphorus are found, we should be cautious in drawing hasty conclusions from the mere presence of a trace of phosphoric acid in the distillate.

The phosphorescence may often be detected by merely boiling the organic matter in a glass retort.

6. It is important to remember that the luminosity is destroyed by alcohol, ether, and turpentine vapours (the two former soon passing off), as well as by iodine, calomel, corrosive sublimate, and metallic sulphides, in the presence of free sulphuric acid.

FIG. 8.



It is always advisable, if possible, in phosphorus poisoning to examine the urine, as the existence of large quantities of earthy and alkaline phosphates will be important. To do this, proceed as follows:

Collect the urine, acidulate, if there is a precipitate, with hydrochloric acid. Add a solution of sulphate of magnesia and excess of ammonia. Filter immediately, dry, ignite, and weigh.*

Remember that phosphorus is a constant constituent of animal solids and fluids :—

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* A curious case is recorded in the "Lancet," 1845, vol. ii., p. 503, by Dr. Collier, of a man who was poisoned by drinking his own urine for nine days, which he was advised to do by an old woman.

Flesh contains about . . .	0·1	per cent of phosphates.
Blood ,, ,, . . .	0·06	,,
Liquid albumen ,, . . .	0·2	,,
Milk ,, ,, . . .	0·25	,,
Cheese ,, ,, . . .	0·06	,,
Peas ,, ,, . . .	0·3	,,
Potatoes ,, ,, . . .	0·06	,,
Bread ,, ,, . . .	0·1	,,
Bones ,, from . . .	20· to 60·	,,
The dry residue of urine contains from	7· to 10·	,,

Lastly note, the most conclusive results in the search for phosphorus are to be found in the odour, the luminosity, the products of the combustion, and the products of the distillation.

Cases of Poisoning by Phosphorus.

1.

"Lancet," Sept. 14, 1844, p. 754 (Mr. Reedal). Male: æt. 10. A quantity of phosphorus given by a quack, and supposed to be the cause of death. None had been taken for 10 days before death.

Symptoms.—Convulsions, stupor, insensibility.	*Result.*—Death.	*Post-mortem.*—Brain congested in parts; lungs congested; lining membrane of the heart red; mucous membrane of stomach softened, and very inflamed.

2.

"Lancet," June 12, 1869, p. 836 (Mr. Kay). Female: æt. 32. ʒj. of James's Phosphor Paste.

Symptoms.—Pain, vomiting, perfect consiousness; pulse 90; death.	*Result.*—Death in 2 days.	*Post-mortem.*—Œsophagus, stomach, and intestines mahogany colour; lungs congested; both sides of heart full of blood.

3.

"Lancet," Aug. 5, 1871, p. 189 (Dr. Anderson). Female: æt. 2. Sucked 20 matches.

Symptoms.—In 48 hours became drowsy, which continued for 20 hours. Turpentine was administered; vomiting, pain, and thirst came on. On the 5th day the child became unconscious with vomiting and convulsions. Died on the 7th day. (The mother, after she discovered the accident, gave the child a dose of castor oil.)	*Result.*—Death on 7th day.	*Post-mortem.*—Body yellow; heart, lungs, kidney, spleen, normal; the liver large, and distinct traces of fatty degeneration; alliaceous odour noticed on opening the stomach, which was very congested; ileum also congested.

4.

"Virchow Jahresber," 1868, p. 311. Sucking matches.

Symptoms.—Stools of a green colour; peculiar odour in breath, perspiration and urine.	*Result.*—Death in 11 days.	*Post-mortem.*—Mucous membrane of œsophagus, anterior part of pharynx and epiglottis destroyed; that of stomach and duodenum intact; the white blood corpuscles increased in quantity, and the red diminished; fatty changes in liver and spleen.

5.

"Edinburgh Monthly Journal," Oct., 1860. Female: æt. 26. Lucifer matches taken in coffee.

Symptoms.—An emetic was given in 1 hour; no pain, or purging; on the 4th day febrile symptoms set in, with jaundice and bloody vomiting; vomited matters appeared luminous.	*Result.*—Death in 7 days.	*Post-mortem.*—No inflammation of stomach, gullet, or small intestines; one red patch was found in the cœcum, and one in the colon; brain congested; bloody effusions in the chest and abdomen.

6.

Taylor's "Medical Jurisprudence," vol. i., p. 243 (Mr. Parsons). Female. A quantity of phosphorus paste.

Symptoms. — Thirst, and phosphorus odour of breath, but no well-marked symptoms until the 5th day, when purging and sickness came on.	*Result.*—Death in 6 days.	*Post-mortem.*—Body putrefied rapidly; soon became livid, the finger-nails appearing very blue.

7.

"Lancet," June 13, 1857, p. 600 (Dr. Bingley). Male: æt. 50. A quantity of phosphorus paste.

Symptoms.—Found dead in the morning, after having been seen well at noon the day before.	*Result.*—Death.	*Post-mortem*—Great muscular rigidity; brain congested; heart nearly empty and flaccid; portions of mucous membrane destroyed in gullet, stomach, and small intestines. On opening the stomach a white vapour escaped, having a phosphorus odour.

8.

"Lancet," April 13, 1867, p. 459 (Dr. Habershon). Female. Rat poison mixed with water (= to about three grains of phosphorus).

Symptoms.—Breath phosphorescent; vomiting and purging, which ceased in 2 hours; jaundice on 5th day, with severe pain in loins; abdomen distended; liver enlarged; urine albuminous; temperature low (89·8); died on the 5th day.	*Result.*—Death on 5th day.	*Post-mortem.*—Fatty degeneration of liver, kidneys, pancreas, heart, gastric follicles, and spleen; degeneration of voluntary muscular fibres.

9.

"British Medical Journal," Nov. 30, 1867, p. 500 (Dr. Reith). Female: æt. 21. Phosphorus paste; two doses taken at an interval of 48 hours.

Symptoms.—In 8 hours after the last dose severe vomiting and purging came on; continued to get better for 4 days, and at the end of the 4th day died suddenly.	*Result.*—Death on 4th day.	*Post-mortem.*—Blood very fluid; hæmorrhagic spots on the surface of the heart; muscular tissue pale and loaded with fat cells; liver seemed like "an aggregation of oil drops."

10.

"British Medical Journal," Oct. 23, 1869, p. 454 (Mr. Waterhouse). Female: æt. 20. 1*d.* bottle of James's phosphor paste. (Does it contain strychnia?)

Symptoms.—Became unconscious in 1 hour; Opisthotonos and tetanic spasms soon set in; no vomiting; stomach-pump used; for some days great thirst; urine scanty, and no appetite.	*Result.*—Recovery.	

11.

"Medical Times and Gazette," Nov. 19, 1859, p. 512. Æt. three months. Several matches sucked.

Symptoms.—Colic, vomiting, diarrhœa, garlic smell of breath.	*Result.*—Death in 20 hours.	*Post-mortem.*—Stomach very rotten; bladder colourless and empty.

12.

"Medical Times and Gazette," Nov. 19, 1859, p. 512. Male: æt. 46. Ate the paste of two boxes of matches.

Symptoms.—Great pain and vomiting, but rallied the next day so as to return to work; had a relapse on 2nd day, and died the day following.	*Result.*—Death on 3rd day.	

13.

"Medical Times and Gazette," May 3, 1862, p. 463 (Professor Frerichs). Female. Ate the tops of 1000 lucifer matches.

Symptoms.—Jaundice; enlargement of liver; urine albuminous; not much pain, and no nervous symptoms.	*Result.*—Death.	*Post-mortem.*—Blood thin, not coagulated, and the colour of cherry juice; liver enlarged and very fatty.

14.

"Medical Times and Gazette," Oct. 10, 1863, p. 378 (Mr. John Dawson). Female: æt. 27. A jar full of phosphor rat-paste.

Symptoms.—Drowsiness; breath smelt of phosphorus; no pain; great thirst; vomiting; on the third day the body was bluish, and the odour of phosphorus from the breath distinct; death 63 hours after admission.	*Result.*—Death on 4th day.	*Post-mortem.*—Lungs gorged with dark blood; heart and liver were both pale and rotten; stomach pale externally; the mucous membrane was dusky red at the cardiac end and raised in patches; no perforation; intestines, except lower part of ileum, pale; blood thick, and dirty red in colour.

15.

"Medical Times and Gazette," Oct. 8, 1864, p. 386 (Dr. Woodman). Females: 19 and 26. Ate a penny box of phosphorus paste between them.

Symptoms.—Seen in 1 hour; breath was luminous, and smelt strongly of phosphorus; this lasted in one case for 3 days; both had burning pain in the mouth and stomach; the tongue in both was very red, and bare of epithelium; both had urticaria; both had hæmatemesis, and both had a great desire to sleep.	*Result.*—Recovery in 10 days.	

16.

Beck's "Medical Jurisprudence," vol. ii., p. 511. Male. 1·5 grains.

	Result.—Death on the 12th day.	

17.

Wharton and Stillé's "Medical Jurisprudence," p. 505. Æt. 2½. Sucked eight matches.

	Result.—Death.	

18.

Wharton and Stillé's "Medical Jurisprudence," p. 50. Æt. two months. Sucked two matches.

	Result.—Death.	

19.

"Chemical News," April, 1860, p. 207. Female. 30 or 40 lucifers taken in milk.

	Result.—Death in 48 hours.	

20.

"United States Dispensatory," 1865, p. 644. Child. Teaspoonful of phosphorus paste.

Magnesia administered.	*Result.*—Recovery.	

21.

"Guy's Hospital Reports," 1868, p. 242 (Dr. Taylor). Female: æt. 13. Phosphorus paste.

Symptoms.—The first vomit was luminous; great pain.	*Result.*—Death on the 6th day.	*Post-mortem.*—Ecchymosed patches on the skin of the chest and abdomen; stomach not inflamed, but contained a thick bloody fluid; intestines normal; liver fatty.

22.

"Gaitier's Toxicologie," vol. i., p. 87. Female: æt. 52. One grain in divided doses during four days.

Symptoms.—Great pain.	*Result.*—Death in 3 days.	*Post-mortem.*—Gullet, stomach, and small intestines inflamed.

23.

"British and Foreign Medical Chirurgical Review," October, 1859 (Dr. Lewinsky). Female: æt. 22. Phosphorus composition scraped off matches.

Symptoms.—Pain occurred very soon; vomiting of luminous matter; jaundice on third day; convulsions and coma.	*Result.*—Death on 6th day.	*Post-mortem.*—Stomach and intestines filled with a blackish-brown fluid; bladder contracted and empty; heart contracted.

24.

Casper's "Forensic Medicine," vol. ii., p. 100. Female: æt. 20. 3 grains of phosphorus.

Symptoms.—Poison taken at 6 in the evening; had a restless night, and vomited once.	*Result.*—Death in 12 hours.	*Post-mortem.*—Luminous vapours issued from anus and vagina 48 hours after death; intestines pale; stomach not inflamed; liver, spleen, kidneys, and bladder congested; heart empty.

25.

"Med. Chi. Zeitung," 1826, vol. iv., p. 183 (Dr. Flachsland). Male: æt. 21. Quantity (?); taken on bread with butter.

Symptoms.—Pain; intense vomiting; fragments of phosphorus passed by bowels.	*Result.*—Death in 40 hours.	*Post-mortem.* — Stomach and bowels externally inflamed; mucous membrane of stomach and intestines gangrenous; large intestines very contracted; spleen and kidneys inflamed.

26.

"Révue Medicale," 1829, vol. iii., p. 429. Male. 1 grain on July 2, 2 grains on July 21, 3 grains on July 22.

Symptoms.—On the 22nd vomiting, with delirium; convulsions, and paralysis afterwards set in; death took place on the 29th.	*Result.*—Death on 7th day.	

27.

"Medical Times and Gazette," Aug. 30, 1873, p. 235. Male. Sucked 42 matches=about [illegible] grains.

Symptoms.—Severe symptoms in 2 hours.	*Result.*—Death in 13 hours.	*Post-mortem.*—Stomach very pale, but except one red patch, there were no special post-mortem appearances.

Other Cases of Phosphorus Poisoning, See

"British Medical Journal," Jan. 1, 1870, p. 18. (Lucifer matches.)
"British Medical Journal," March 5, 1870, p. 246. (Lucifer matches.)
"Medical Times and Gazette," July 9, 1864, p. 50. (Death from manufacture of matches; Dr. Letheby.)
"Medical Times and Gazette," Dec. 1, 1855, p. 560. (Death from phosphorus rat-poison.)
"Medical Times and Gazette," Dec. 22, 1860, p. 609. (From sucking lucifers.)
"Medical Times and Gazette," Oct. 19, 1867, p. 447. (F. 4½; Dr. Hillier.)
"Medical Times," Oct. 21, 1843, p. 33. (Various cases.)
"Medical Times," Dec. 19, 1847, p. 224. (Salivation and diseased jaw from fumes.)
"British Medical Journal," April 30, 1864, p. 487. (Death from phosphorus.)
Taylor's "Medical Jurisprudence," vol. i., p. 242. (Reg. *v.* Fisher.)
Horn's "Vierteljahrsschrift," 1866, vol. i., p. 271. (Dr. Kessler.)
Casper's "Wochenschrift," 1846, p. 117. (Six grains in divided doses. Death.)
"Ann. d'Hygiène," 1857, vol. i., 422. (Deaths from 4·6 grains, 2·3 grains, and ⅛th grain.)
"Medical Chirurgical Transactions," 1867, vol. 50. (Case quoted by Dr. Habershon. Death 30 minutes.
"Medical Press," Nov. 15, 1865, p. 434.

CHAPTER VII.

THE HALOID ELEMENTS.

Chlorine — Hypochlorous acid — Bromine — Symptoms — Iodine — Symptoms — Treatment—Post-mortem appearances—Toxicological analysis—Iodide of potassium—Tests—Cases of poisoning—Fluorine—Manufacture of superphosphate.

CHLORINE ($Cl = 35{\cdot}5$).

The chief source of chlorine is common salt ($Na\,Cl$). Chlorine is both an active deodorizer and a powerful bleaching agent, and on account of these properties is largely used both in the sick room and the manufactory. Even when largely diluted with air, chlorine produces, if inhaled, considerable inflammatory action in the lungs, air-passages, and eyes. It is remarkable, however, how large a quantity can be breathed with impunity by those accustomed to it. We are told that the men constantly at work in a chlorine atmosphere never get fat, or if fat when they commence work that they soon get thin, but that it does not shorten their days. If the gas is injected into the jugular veins it destroys life rapidly (Nysten and Orfila), the blood after death being fluid and dark coloured. One part in two hundred of air will kill a sparrow in five minutes (Tidy). It has been noticed that the lungs of animals killed by chlorine are yellow (Broughton). When injected into the stomach in a fluid state death is rapid and the stomach is found after death intensely inflamed.

After poisoning by chlorine, the patient must be at once brought into the fresh air and made to breathe ammonia, or very dilute sulphuretted hydrogen, or ether vapour. The inhalation of steam is also beneficial.

The colour, odour, and bleaching properties of the gas constitute its tests.

Cases of Poisoning with Chlorine.

1. "Christison," p. 803, from "Wibmer." Male: adult. Dilute chlorine.		
Symptoms.—Immediate irritation in the epiglottis, windpipe, and bronchial branches; cough; tightness and pressure in chest; inability to swallow, difficulty in breathing; severe sneezing; protrusion of eyes; swelling of face; great relief was afforded by breathing a little sulphuretted hydrogen, and in 1½ hours he was well.	*Result.*—Recovery.	
2. "Lancet," April 27, 1839, p. 194. Male: adult. Dilute chlorine.		
Symptoms.—Severe effects, very much as above.	*Result.*—Recovery.	

Hypochlorous Acid ($H Cl O$).

The Hypochlorites or Bleaching Powders.

Chloride of Lime, (Bleaching powder) = Chloride and Hypochlorite of Calcium. ($Ca Cl_2$, $Ca Cl_2 O_2$.)

Hypochlorite of Sodium ($Na Cl O$), *Chlorinated Soda.*

The hypochlorites are largely used by the French washerwomen on account of their bleaching properties (l'eau de javelle). They are very soluble in water and give off a strong chlorine odour, which is much more marked if an acid be added.

It is important to note that a hypochlorite may prove poisonous, and yet none be found after death in the contents of the stomach, an inert chloride having been produced. The symptoms of poisoning by the hypochlorites seem to be irritation of the alimentary canal, vomiting, and general wasting of the body.

In cases where there is a suspicion of their administration, search must be specially made for stains on linen and clothes. The stains on black materials are usually of a reddish brown colour.

In the manufacture of chloride of lime (bleaching powder) a little chlorine will at times escape from the works, and be a cause of nuisance and litigation. It is either due to accident or carelessness. The liquid muriatic acid which flows from the condensing towers at the alkali works is that which is generally used for producing the chlorine. The acid (gravity 1125 to 1140; or 25 to 28, Twaddell) is run into a still containing oxide of manganese and subjected to heat. The chlorine evolved by this means is passed over slightly damp, well slaked lime placed in layers 3 to 6 inches deep. The oxide of manganese is usually recovered from the material in the retort (thus preventing it becoming an annoyance), by treating it, first with carbonate of lime, which does not decompose the chloride of manganese, but merely serves to neutralize any free acid. The clear supernatant solution of chloride of manganese is then drawn off into an "oxidator," where it is treated with milk of lime, which decomposes the chloride of manganese, and throws down a precipitate of the oxide. This protoxide is now converted into peroxide by blowing air into the mixture. This is allowed to settle and is then collected.

Chlorine is also prepared from the gaseous hydrochloric acid from salt cake furnaces, by acting upon it at a low red heat with atmospheric air, by which means the hydrogen is oxidized and the chlorine set free. The gas, being first cooled and dried by passing it through a sulphuric acid scrubber, is then conveyed to the lime chambers. This method of generating chlorine demands care and attention, as the high temperature of the decomposing apparatus is very likely to lead to fissures and cracks in the apparatus, and in this way to the escape of irritating gases.

Case of Poisoning by Hypochlorite of Soda (Chlorinated Soda).

Reese, "Manual of Toxicology," p. 188, from "Tardieu." Æt. 6 months. Believed to have been administered on several occasions during a period of two months.		
Symptoms.—Peculiar odour exhaled by breath; irritation of alimentary canal; vomiting; failing health.	*Result.*—Death.	*Post-mortem.*—No odour in the stomach of chlorine. The last dose had clearly been given 6 days before death; abnormal amounts of chlorides were found in urine and kidneys.

BROMINE (Br. = 80).

(Boils at 63·° C. Sp. gr. 2·966.)

Bromine is largely used in photography. It is a dark red volatile liquid, having a very unpleasant odour and taste. It is intensely corrosive and very destructive to animal tissues. The vapour, which is given off at common temperatures, is very irritating to the eyes and lungs and induces a kind of catarrh.

Given internally it is rapidly converted into hydrobromic acid (H Br).

In a free state its colour, odour, and peculiar fumes are its distinctive tests It is not, however, likely to be found in this form in a medico-legal enquiry. In such an investigation proceed as follows :—Filter the contents of the stomach and add a little chlorine water to, or pass a few bubbles of chlorine (avoiding an excess) through the filtrate. Shake the whole up with ether and allow the mixture to stand for the ether to separate, which, if bromine be present, will have a yellow or reddish colour. Decant, and after the addition of a few drops of potash solution, evaporate off and preserve the ether. Dissolve the bromide which remains in the flask in water, and again set the bromine free by the addition of a little chlorine water. If now a few drops of starch water be added, the yellow bromide of starch will be at once formed.

Injected into the jugular vein, Barthez, Dieffenbach, and Butske noticed that animals either die almost directly or else recover. Thus administered, 12 grains killed a dog, and 5 grains very nearly killed a horse, whilst cases are recorded of a dog recovering from 17 drops and a cat from 12 drops, the leading symptoms when recovery occurred being sneezing, discharge from the nostrils, rigors and debility.

By introducing it into the stomach the following were the results—

Barthez found 40 to 60 drops killed dogs in four or five days, the symptoms observed being dilated pupils, sneezing and vomiting, the vomit a few minutes after the administration of the poison having no appreciable odour of bromine. Butske found 5 grains killed a dog in twenty-four hours with convulsions. The stomach and duodenum were found much congested after death.

So far as we know, there is no case of poisoning symptoms being induced by the use of Bromide of Potassium.

Case of Poisoning with Bromine.

"New York Journal of Medicine," Nov., 1850 (Dr. Sayre). Male: æt. 24. ʒj of bromine taken on an empty stomach.		
Symptoms.—Immediate difficulty of respiration; intense pain in stomach; great anxiety, with trembling of hands; pulse rapid.	*Result.*—Death in 7 hours.	*Post-mortem.*—Stomach externally injected; internally it was covered with a thick black layer, the mucous membrane being intensely inflamed; viscera near stomach were of a deep yellow colour; peritoneal coats of stomach and duodenum injected; stomach contained 4ozs. of a thick reddish fluid, having a bromine smell.

IODINE (I = 127).

Iodine is obtained from the ashes of sea plants. It is scaly in form, deep violet in colour, and peculiar in odour. It is sparingly soluble in water, more soluble in certain saline solutions, such as iodide of potassium, and very soluble in spirit. If a very strong solution be applied to the skin it acts as a corrosive, and stains the skin yellow, but the colour can be removed by treating it with an alkali.

The vapour of iodine is very irritating. It fuses at 107·2° C. (225° F.) and boils at 175° C. (347° F.)

Symptoms, Dose, &c.

The symptoms of acute poisoning by iodine are those of an irritant and corrosive poison. There is immediate pain and heat in the throat and abdomen, with vomiting and purging. The vomit will probably be of a yellow or brown colour, possibly bloody, but blue or black if any starchy food was present in the stomach when the poison was taken. The stools often contain blood. Giddiness and fainting, with headache and convulsive movements are not uncommon.

Applied externally or given internally in small doses, certain chronic or secondary effects are induced (iodism). There is a general irritability of the alimentary canal and consequent indigestion, frequent vomiting, purging, and pain in the stomach, a loaded tongue, an enlarged liver, and considerable palpitation and cramps. An increase of all the secretions is usual, whilst salivation, a general wasting of the body, and specially in the female absorption of the breasts, and in the male of the testicles, are said to be ordinary symptoms. Dr. Rivers believes barrenness to be induced by the use of iodine.

As regards *the poisonous dose* the records of cases are perplexing. Recovery is recorded after ten grains taken in one dose (Magendie), four grains taken daily for fifteen months (Christison), thirty grains taken daily (Gully and Delissez), twelve grains taken for eighty days (Kennedy), and three drams of the tincture taken in one dose by an infant (Wright). In many of the cases no symptoms worth recording occurred. On the other hand bad effects are said to have resulted from half a grain taken three times daily for a week, and from even a less quantity. Death has resulted from twenty grains of iodine, whilst recovery is recorded after a dram and a half, the symptoms produced, however, being severe. When death occurs, it usually happens within thirty hours after the poison has been taken.

It may be well to note here that iodine may be easily detected in the blood, urine, saliva, milk and sweat, even after a mere medicinal dose. After forty minutes it will be found in the urine and will probably not disappear for five days. The iodine is present, however, not in the free state, but as hydriodic acid into which it is rapidly converted.

Treatment.

The *treatment* will consist in the free administration of farinaceous foods after vomiting has been produced by emetics.

Post-mortem Appearances.

The post-mortem appearances that have been noted are those of a corrosive irritant poison. Orfila noticed in dogs little yellow ulcers in the stomach, whilst the enlargement and congested state of the liver seems constant. The lungs are generally found natural. The brain is usually more or less congested.

Toxicological Analysis.

In conducting a toxicological investigation first of all filter the contents of the stomach, and if the filtrate be clear and colourless, or nearly so, test at once for iodine by adding a little starch solution, when, if iodine be present, a blue colour will be produced, disappearing temporarily on the application of heat, and permanently by the action of sulphuretted hydrogen. If, however, the filtrate be too dark coloured to allow of its being at once treated with starch, shake it up with its own bulk of ether, and after allowing the ether to separate, decant the ethereal solution, and test this for iodine. If this also fails, the process suggested for iodide of potassium (page 88) must be adopted.

Iodide of Potassium ($KI = 166$).
(Hydriodate of Potash.)

This salt is much used in medicine and in the laboratory.

It is prepared

(1) By adding iodine to a solution of potash when iodide of potassium (KI) and the iodate of potassium (KIO_3) are formed

$$6\,KHO + 3\,I_2 = KIO_3 + 3\,H_2O + 5\,KI.$$

This is then heated, and in this manner the oxygen from the KIO_3 is driven off.

(2) By dissolving carbonate of potash in hydriodic acid.

$$K_2CO_3 + 2\,HI = CO_2 + H_2O + 2\,KI.$$

(The KI often contains notable quantities of K_2CO_3.)

It is a white crystalline solid (cubes) somewhat deliquescent, and very soluble in water and alcohol.

Symptoms. Treatment.

Owing to peculiar idiosyncrasies, very small doses of the salt (such as twelve and even five grains) have at times produced alarming results. By some persons, on the other hand, even dram doses will be taken with impunity. Salivation has been known to occur from its exhibition on numerous occasions. The general symptoms produced by it are those of severe catarrh. Sometimes, however, violent abdominal pains with purging and vomiting, in addition to the ordinary symptoms such as running at the nose and eyes, thirst, headache, dyspnœa, &c., have been noticed. It has been stated by some French physicians that it is capable of acting as an abortive (?). In some cases an eruption like that of small pox, or a kind of bullous eruption like Hydroa, is the result of medicinal doses.

The *treatment* must consist in the use of the stomach-pump, emetics, diluents, and such other remedies as the case suggests.

Tests.

1. With *mercuric chloride* ($Hg\ Cl_2$) a red precipitate of mercuric iodide ($Hg\ I_2$) is formed, which is soluble both in excess of iodide of potassium and of the test solution.
2. With *acetate of lead*, a yellow precipitate is produced of iodide of lead ($Pb\ I_2$).
3. Mixed with a little *starch water*, and *a very little chlorine water*, the blue iodide of starch is formed. By warming the colour goes, whilst if too much chlorine be present, chloride of iodine is formed, and this is colourless.
4. *Iodide of potassium* is decomposed by nitric acid, chlorine, &c., iodine being liberated.
5. *Nitrate of silver* gives a yellowish white precipitate of iodide of silver ($Ag\ I$) insoluble in nitric acid, and sparingly soluble in ammonia.

Toxicological Analysis.

In organic mixtures Dr. Guy advises that sulphuretted hydrogen be passed through the mixture of the solids and liquids to convert any free iodine into hydriodic acid. Gently heat the mixture to drive off any excess of the gas, and afterwards add an excess of potash, filter, and evaporate to dryness. Char the residue in a covered crucible, powder, treat with water and filter. Evaporate this down to a small bulk, and then add chlorine to set the iodine free, and a little starch, when the characteristic blue colour will appear.

Cases of Poisoning by Iodine.

<table>
<tr><td colspan="3">1.
"Medical Times and Gazette," Dec. 28, 1861, p. 669 (Dr. Bambridge). Female: æt. 50. ℥j. of tincture of iodine by mistake for black draught (=ʒss. of iodine), taken on empty stomach.</td></tr>
<tr><td><i>Symptoms.</i>—Instant burning pain; emetics were given directly; great debility; loss of taste.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">2.
"Medical Times and Gazette," Nov. 5, 1864, p. 488 (Dr. Gillespie). Male: æt. 17. Iodine applied to enlarged glands, the patient suffering at the time from remittent fever.</td></tr>
<tr><td><i>Symptoms.</i>—In 5 hours vomiting and purging of a yellow fluid came on; pain, and suppression of urine; mind clear to the last.</td><td><i>Result.</i>—Death in 30 hours.</td><td><i>Post-mortem.</i>—Brain somewhat congested; liver large and congested; gall bladder full of dark bile; stomach and intestines had ecchymosed spots upon them; urine contained iodine.</td></tr>
<tr><td colspan="3">3.
"Provincial Journal," June 30, 1847, p. 356. Female. ʒj. of iodine in ℥j. of spirit.</td></tr>
<tr><td><i>Symptoms.</i>—Almost immediate pain in throat and stomach; retching and vomiting; eyes suffused and prominent.</td><td><i>Result.</i>—Death in 24 hours.</td><td></td></tr>
</table>

4. "Medical Times and Gazette," Dec. 28, 1861, p. 669. ʒss.		
	Result.—Recovery.	
5. "Essay on the Effects of Iodine" (Dr. Gairdner), 1824, p. 20. Æt. four. 20 grains taken as tincture.		
	Result.—Death in a few hours.	
6. Horn's "Archiv," 1829, vol. i., p. 340 (Dr. Jahn). Overdose ?		
Symptoms.—Violent pain in abdomen; vomiting; profuse bloody diarrhœa; coldness of skin; rigors; quivering of sight, and rapid pulse.	*Result.*—?	
7. "Christison," page 194. ʒjss. in solution of iodide of potassium.		
Symptoms.—Immediate nausea, and great pain in stomach; the vomit was yellow; restlessness; headache; giddiness. Recovery in 5 days.	*Result.*—Recovery.	
8. "Christison," page 194. ʒijss.		
Symptoms.—Immediate burning pain in throat and stomach; vomiting had to be induced by draughts of warm water; and in [illegible] hours the patient recovered.	*Result.*—Recovery.	

Cases of Poisoning by Iodide of Potassium.

1. "Medical Gazette," Sep. 3, 1841. Male: adult. Gr. iii., three times daily. Four doses taken.		
Symptoms.—Had a shivering fit; thirst; vomiting; purging, with great prostration.	*Result.*—Recovery.	
2. Taylor's "Medical Jurisprudence," p. 240 (Mr. Erichsen). Gr. v.		
Symptoms.—Alarming symptoms of difficulty of breathing and of catarrh.	*Result.*—Recovery.	
3. "Medical Gazette," xxvii., p. 588 (Dr. Laurie). Adult. Gr. vijss.		
Symptoms.—Dryness of throat; difficulty of breathing.		

FLUORINE ($Fl = 19$).

In one matter only are fluorine compounds likely to become a matter of importance to the medical jurist.

The manufacture of "superphosphate" is, unless properly conducted, likely to be a cause of considerable annoyance. The materials used are ground coprolites, crushed bones, spent animal charcoal from sugar refineries and animal refuse of all kinds. These are treated in a proper apparatus with dilute sulphuric acid. The action of the acid on the fluorides and silicates of the coprolites is to evolve the excessively irritating and acrid *tetra-fluoride of silicon* along with other vapours. The mixer should be air-tight and should be so arranged that it need not be opened externally until the materials in the mixer have passed into the superphosphate room. The gases should, first of all, be conveyed from the mixer into a chamber where they meet with a copious spray of water. This decomposes the tetra-fluoride of silicon, hydrate of silica being formed, which is deposited in a pulpy state, and an acid—hydrofluosilicic acid—set free, which is dissolved by the water. The gases should be now passed through a coke scrubber kept moistened with water, then through a lime purifier, and lastly, through the furnace into the furnace shaft.

CHAPTER VIII.

METALS OF THE ALKALIES.

Potassium—Sodium—Ammonium—Lithium—Rubidium—Cæsium.

We need only consider the first three of these in any detail.

The whole group are lighter than water, univalent, and their salts freely soluble in water.

POTASSIUM.

(K = At. wt. 39 : Sp. gr. 0·865 : melts at 62·5 C.)

The metal is prepared by distilling potassic carbonate with charcoal, and condensing the metal in a receiver, containing naphtha.

$$K_2\ CO_3 + 2\ C = K_2 + 3\ CO.$$

Potash ($K_2\ O = 94$).

This is obtained by heating caustic potash with metallic potassium.

$$KHO + K = K_2\ O + H.$$

Potassium Hydrate (KHO) = 56.

(Caustic Potash, Potassa Fusa.)

This is prepared by boiling together slaked lime and commercial "Pearlash," which is an impure carbonate of potash, obtained from wood ashes.

$$K_2\ CO_3 + Ca\ O,\ H_2O = 2\ (HKO) + Ca\ CO_3.$$

Caustic potash is a white, hard, solid substance, and is sold either in lumps or in sticks. It is often of a brownish colour, from the presence of foreign matters. It deliquesces readily, and has a great affinity for carbonic acid.

The Proportion of Anhydrous Potash (K_2O) *in Aqueous Solutions of various Gravities* (Dalton).

Sp. Gr.	Per cent.	Sp. Gr.	Per cent.
1·78	56·8	1·36	29·4
1·68	51·2	1·33	26·3
1·60	46·7	1·28	23·4
1·52	42·9	1·23	19·5
1·47	39·6	1·19	16·2
1·44	36·8	1·15	13·0
1·42	34·4	1·11	9·5
1·39	32·4	1·06	4·7

Soft soap is formed by the action of a solution of caustic potash on fat. The alkaline solution is called "a Lye," which was formerly nothing more than a solution of wood ashes.

Potash dissolves freely in water (100 parts in 50), great heat being thereby evolved. The saturated solution has a sp. gr. of about 2·0, and contains 70 per cent. of anhydrous alkali.

The solubility of the caustic alkali in alcohol is equally as great as its solubility in water. The salts of potash are also very soluble in water, but are not usually soluble in alcohol.

Potash and soda are termed fixed alkalies; *i.e.* they are not dissipated byh eat, like ammonia. Porcelain and glass are attacked by both the fixed alkalies. A solution of potash, kept for a length of time in a glass bottle, will certainly be found to contain silica. Platinum is slightly acted upon by it, but not silver. When brought into contact with animal tissues, a rapid destruction of the tissue results, soluble compounds being formed. Indeed, it will dissolve the tissue of the stomach more readily than acids. It acts energetically on vegetable matters, such as cork.

The impurities of ordinary caustic potash are carbonic acid, sulphuric acid, phosphoric acid, chlorine, silica, and alumina. They are chiefly derived from impure materials, used in the manufacture. Most of them are left behind, when the alkali is purified by dissolving it in alcohol.

Symptoms; Dose, &c.

The symptoms produced by potash and soda are almost identical. There is an immediate nauseous soapy taste due to the rapid disorganization of the mucous membranes. If the poison be swallowed, there will be immediate and intense pain and heat from mouth to stomach. The lips and tongue swell rapidly, and become brown. Violent colicky pains, with intense tenderness in the stomach follow, and are generally accompanied by the vomiting of mucus mixed with blood, epithelium flakes, and shreds of mucous membrane. There is often severe purging of bloody mucus. Slight convulsions have been recorded. The pulse becomes very small and rapid, and the skin cold and clammy. The death (as with mineral acids) may be either very rapid from collapse; or, as is most often the case, it may result from starvation due to secondary causes, such as stricture of the œsophagus, or stricture of one or both openings of the stomach, the taking food under such circumstances gradually becoming more and more difficult, and at last impossible.

As regards dose, forty grains of caustic potash has caused death. This is the smallest dose on record. Half an ounce may be regarded as the poisonous dose under ordinary circumstances.

Death may be rapid; but the patient more often survives the acute symptoms, and dies, after a considerable time, from starvation.

Post-mortem Appearances.

Wherever the poison has gone, there great local action, with broken up and disorganized membranes, will be apparent. This will specially be the case, therefore, in the mouth, throat, gullet, stomach, &c. The larynx is very likely to be more or less inflamed. The stomach may, if a large dose has been swallowed, appear completely black from the extravasation of disorganized blood on its coats. Contraction of the œsophagus and of the stomach, with constriction of the orifices, are usually found in cases where death has occurred after an interval.

Treatment.

The stomach-pump must not, under any circumstances, be used. Dilute vinegar or lemon-juice should be at once administered. Oranges, olive oil (converting thereby the alkali into a soap), and milk may be given freely. Opium, if there is much pain; and stimulants, if there is great depression, are indicated.

Tests:—General Notes respecting Tests for the Alkalies.

Previous to dealing with the tests for the alkalies in detail, it will be useful to note, first of all, a few reactions that are common to all the alkalies, and some that are peculiar to each:—

(*a*) They all have (as well as their carbonates) a strong alkaline reaction.

(*b*) They all are (unlike other metallic oxides) soluble in water.

(*c*) They are—

(1) Not precipitated by *sulphuretted hydrogen*, like tin, gold, platinum, arsenic, antimony, bismuth, mercury, lead, silver, copper, or cadmium.

(2) They are not precipitated by *sulphide of ammonium*, like nickel, cobalt, manganese, iron, chromium, aluminium, or zinc.

(3) They are not precipitated by *carbonate of ammonium*, like barium, strontium, and calcium.

(*d*) The caustic alkalies may be known from their carbonates by the latter effervescing on the addition of dilute hydrochloric acid.

(*e*) *Sulphate of Magnesia* gives with . .	*Carbonates of potash and soda*, a white precipitate.
	Bicarbonates of potash and soda, no precipitate.
	Carbonate of ammonia, no precipitate.

(*f*) *Nitrate of Silver* gives with	*Potash and soda*, a brown precipitate, insoluble in excess of the alkali.
	Ammonia, a brown precipitate, soluble in excess of the alkali.
	The Carbonates, a yellowish-white precipitate,—
	The precipitate being *soluble*, in excess of alkali, with the carbonates of sodium and potassium, but *insoluble*, in excess of alkali, with carbonate of ammonium.

(*g*) Lastly, in every case, previously to applying the several tests to the solution under examination for the alkalies, the absence of metallic oxides must be proved by treating the solution first with sulphuretted hydrogen, then with sulphide of ammonium, and then with carbonate of ammonium.

Tests for Potash.

1. *Perchloride of Platinum* ($Pt\,Cl_4$)

Produces with the chloride of potassium (and for that reason first add hydrochloric acid to the solution you are testing) a yellow crystalline precipitate (octahedra) of the potassio-chloride of platinum ($2\,KCl,\ Pt\,Cl_4$), which is almost insoluble either in cold water or in alcohol.

Every 100 grs. of the double salt = 22·94 grs. of KHO, or 19·26 grs. of $K_2\,O$.

Fallacy.—A similar precipitate is also given with salts of ammonia ($2\,NH_4Cl,\ Pt\,Cl_4$). Hence before testing the solution for potash, it is necessary to prove the absence of ammonia compounds. This may be done as follows:—

A. Boil a little of the solution under examination with a small quantity of caustic soda or potash. If ammonia be present—

(α) The odour of ammonia will be evolved.
(β) A piece of turmeric paper held over the test-tube will be turned of a brown colour.

B. Or, having precipitated the solution with the platinum salt, the precipitate may be further tested as follows:—

Heat the precipitate to redness, dissolve in water, and filter—

(α) If it be a *potash precipitate,* platinum and chloride of potassium will be left after ignition. Act on this with water. A precipitate of chloride of silver will be produced when nitrate of silver is added to the solution.
(β) If it be an *ammonia precipitate,* only platinum will be left, and no precipitate will be produced when nitrate of silver is added to the filtered solution.

2. *Picric or Carbazotic Acid* (alcoholic solution).

A yellow precipitate (long needle crystals), insoluble in alcohol or in excess of picric acid, is produced—

100 grs. of carbazotate of potash = 17·66 of $K_2\,O$.

Fallacies.—A precipitate is also produced with ammonia, with strong soda solutions, with many of the vegetable alkaloids, and with some of the metallic oxides.

3. *Tartaric Acid.*

Added in excess to neutral or alkaline solutions of potash, tartaric acid gives a white precipitate of cream of tartar ($KH,\ C_4\,H_4O_6$). The precipitation is aided by the addition of a little alcohol, and by well stirring the solution. The precipitate is soluble in the mineral acids, in hot water, and in a large excess of cold water.

Fallacy.—A precipitate is also produced with ammonia salts.

4 *Hydrofluosilicic Acid*
Gives a gelatinous precipitate insoluble in hydrochloric acid.

5. *Perchloric Acid*
Gives a white crystalline precipitate.

6. All potassium salts heated on a piece of platinum foil leave a fixed and usually fusible residue.

7. Potassium and its salts give a violet colour to flame, which is entirely obscured by the presence of the merest trace of a sodium salt. The potassium spectrum which consists of two lines, one in the red and one in the blue, is very characteristic, and constitutes a test of great delicacy.

Toxicological Analysis.

The soapy feel, the frothy appearance, and the alkaline reaction of the mixture, are characteristic either of caustic potash, or soda, or their carbonates.

(1) It will generally be sufficient to evaporate the liquid under examination to dryness, and to heat it thoroughly, so as to char the organic matter. The ash is then to be digested in distilled water and filtered, when the alkali will be found in solution as a carbonate. The proper tests may then be applied.

(2) But if it is considered necessary to separate the caustic alkali (whether potash or soda) from the carbonate that may be present, the liquid must first be evaporated to dryness, and the residue treated with absolute alcohol, which will not dissolve the carbonate, but will freely dissolve the caustic alkali. After filtration evaporate the alcoholic solution to dryness, incinerate so as to get rid of organic matter, dissolve the residue in water, and test as directed.

To Estimate Potash Quantitatively.—Add hydrocholoric acid and an excess of perchloride of platinum to the solution. Then concentrate the mixture nearly to dryness. Wash the residue in a mixture of ether and alcohol, so as to remove all excess of the perchloride of platinum. Collect the precipitate on a weighed filter; again wash with alcohol, and dry and weigh—

$$\begin{aligned} 100 \text{ parts} &= 22{\cdot}94 \text{ of } KHO \\ &= 19{\cdot}26 \text{ of } K_2O \\ &= 28{\cdot}5 \text{ of } K_2CO_3. \end{aligned}$$

Potassic Carbonate ($K_2CO_3 = 138$).

This is sold by oilmen, and called either (1) *Potash*, which is a deliquescent solid, and largely used for cleaning lamps; or (2) *Pearlash*, which is chiefly used for washing purposes. It was originally called potash, because it was contained in the ashes left after the combustion of wood. These ashes are lixiviated (*i.e.* mixed with water), and the clear solution boiled down in iron pots (hence the name *Potash*), and the residue thus formed afterwards calcined and sold as American ash or pearlash.

It is very deliquescent, very soluble in water, insoluble in alcohol, turns red litmus blue, and melts at a red heat without decomposition. If sand (SiO_2) be mixed with it whilst in this melted state, potash-glass or potassium silicate is formed, carbonic acid being expelled.

On passing carbonic acid through a solution of carbonate of potash, a potassic bicarbonate ($KHCO_3 = 100$) is formed.

The symptoms and post-mortem appearances produced by the carbonate are similar to, but less intense than those caused by the caustic alkali. In Dr. Barclay's case, where death occurred after a considerable interval, the lower opening of the stomach was so contracted as only to admit a probe.

Half an ounce may be considered a poisonous dose. Death has occurred as rapidly as three hours after taking this poison; but it would seem that it more generally causes death after a considerable interval by secondary symptoms, such as by stricture of the gullet or stomach.

For tests and examination of organic mixtures, *vide Potash.*

Potassic Nitrate ($KNO_3 = 101$).

(Nitre, Saltpetre, Sal Prunella.)

This salt is found in India upon the soil. It is collected by the natives, dissolved in water, and the solution allowed to evaporate in the sun, crystals of the salt being obtained in this way. It is formed whenever animal nitrogenized matters are decomposed in contact with clay, or with any substance capable of yielding potash.

It is largely used in making gunpowder. It is a white crystalline solid (striated six-sided prisms), having a cool, saline taste. It is soluble in three and a half times its weight of water. It melts when heated, and when cast into balls constitutes the sal-prunelle balls of the shops.

The cases of poisoning by it have been usually accidental, and commonly arise from its having been taken by mistake for the sulphates of soda or magnesia.

The *symptoms* it occasions are severe burning abdominal pains, with nausea and bloody vomiting, occasional purging, coldness in the limbs, nervous symptoms, such as convulsions and partial paralysis, tremors, great prostration, and collapse. The secretion of urine is often arrested.

One ounce has in several cases proved fatal; but recovery has taken place after two ounces. Very large doses have been given medicinally. Death is often as rapid as two, three, or five hours; but life has been prolonged to nearly three days.

Post-mortem appearances:—Considerable inflammatory action in the stomach and intestines, the mucous membrane being detached. Bloody mucus may be found in large quantities in the intestinal tract, whilst even perforation of the stomach has been noted.

As regards *treatment*, you must get rid of the poison by emetics and the stomach-pump, but which, if used, must be employed with very great care. Demulcents may be given freely. Opium and stimulants may be required.

Inorganic mixtures. (*Vide* Potash and Nitric Acid.)

Bi-Sulphate of Potash ($KHSO_4 = 136$).

(Sal Polychrest, Sal de Duobus.)

This salt is somewhat popular in France, from the power it is believed to possess of producing abortion; and with that object it has been generally administered.

Symptoms.—Dr. Letheby pointed out that its action is that of a true and powerful irritant; pain, nausea, vomiting, purging, and cramps being induced.

It should be remembered that sulphate of potash is said to be often contaminated with sulphate of zinc, as well as with arsenate of potash, derived from the arsenic present in the sulphuric acid used in its manufacture.

Ten drachms has proved fatal in two hours.

The treatment is the same as that directed for nitrate of potash.

In organic mixtures, evaporate the mixture to dryness, incinerate, and take up the sulphate with water.

It must be remembered that a trace of sulphate is present in all animal tissues and fluids.

Bi-Tartrate of Potash ($KH\ C_4\ H_4\ O_6 = 188$).

(Cream of Tartar, Argol.)

By boiling this salt with carbonate of potash, a di-potassium tartrate is formed = ($K_2\ C_4\ H_4\ O_6$).

By boiling it with carbonate of soda, the potassio-sodium tartrate, or *Rochelle salt* is formed ($K\ Na\ C_4\ H_4\ O_6$).

By boiling it with antimonious anhydride ($Sb_2\ O_3$), the potassio-antimonious tartrate, or *tartar emetic*, is formed ($2\ [K\ (Sb\ O)\ C_4\ H_4\ O_6]\ H_2\ O.$)

Cream of tartar is a white solid, insoluble to a great extent in water, the solution having a feebly acid reaction.

Its action is that of an irritant poison.

Death has been caused in forty-eight hours by two and a half ounces.

The *treatment* is the same as that directed for nitrate of potash. Small doses of bicarbonate of potash in milk may be given with advantage.

The tartrates are known by their swelling up when ignited, giving off an odour of burnt sugar, and leaving a large charcoal residue. They also blacken when heated with strong sulphuric acid.

Alum: Potassium Alum = ($K_2\ SO_4,\ Al_2\ 3\ SO_4 + 24\ H_2\ O = 949.$)

(NOTE.—NH_4, or Na may be substituted for the K; or Fe_2, Mn_2, or Cr_2 for the Al_2.)

Alum, as found in the shops, is a colourless crystalline body. It is not often used as a poison. Its taste is sour, and its reaction when dissolved acid. The solution produces cubical or octahedral crystals when evaporated down or allowed to crystallize. It is soluble in eighteen parts of cold water.

Alum is largely used in dyeing, in the arts, and in medicine. The symptoms produced by it in poisonous doses are those of an irritant.

The *treatment* consists in getting rid of the poison by emetics and the stomach-pump. Lime-water has been recommended.

TESTS:—The *Sulphuric Acid* gives a white precipitate, with nitrate of baryta.
The *Alumina* gives a gelatinous precipitate, with ammonia.
The *Potash* gives a crystalline precipitate, with perchloride of platinum.

Sulphide of Potassium ($3K_2S_3 + K_2SO_4 = 696$).
(Liver of Sulphur.)

All the sulphides act as irritant poisons. Sometimes their action is very rapid. That they have been swallowed will be known by the intense odour of sulphuretted hydrogen in the breath and in all discharges.

On examining the stomach after death the ordinary post-mortem appearances of an irritant poison will be found, and probably the deposition of sulphur on the lining membranes.

The treatment is that of irritant poisoning generally. Dilute solutions of bleaching liquids (chloride of lime or soda) are recommended.

Tests.—Sulphuretted hydrogen will be given off when the material is treated with an acid, and will be known by its blackening lead paper.

Binoxalate of Potash. (*Vide* Oxalic Acid.)
Iodide of Potassium. (*Vide* Iodine.)
Cyanide of Potassium. (*Vide* Hydrocyanic Acid.)

Cases of Poisoning by Potash and Salts of Potassium.

(I.) CAUSTIC POTASH.

1.

Berlin "Medical Zeitung," 1857, No. LI. (Dr. Deutsch). Male: æt. 55. A glass of soap lees (=30 per cent. of caustic potash; quantity taken = ℥ss of potash).

Symptoms.—Mouth and fauces immediately became bluish-red; pain intense; feeling of constriction in œsophagus; inability to swallow; slight convulsions; for a long time the inability to swallow continued; and after 28 weeks he died from inanition.	*Result.*—Death in 28 weeks.	*Post-mortem.*—The lower part of the œsophagus was immensely thickened; the cardiac aperture of the stomach would scarcely admit a crow-quill; no ulcers; the stomach was small, empty, contracted, and bloodless; otherwise both stomach and intestines were normal.

2.

Taylor's "Medical Jurisprudence," vol. i., p. 231. Female: adult. ℥jss of common potash solution (= 5 per cent. of KHO).

Symptoms.—Irritation, from which she recovered for a time. Died of exhaustion.	*Result.*—Death in 7 weeks.	

Cases of Poisoning by Caustic Potash are recorded in—

"Medical Times and Gazette," Aug. 1, 1863, p. 130. (Death. Female: æt. 53.)
"Arch. d. Heilk.," 1872, p. 213. (Death in 22 hours from lobular pneumonia.)
Sir Charles Bell's "Surgical Observations," part I., p. 82.

(II.) CARBONATE OF POTASH.

3.

Taylor's "Medical Jurisprudence," p. 231. Male: boy. ℥iij of a strong solution.

	Result.—Death in 3 hours.	

4.

Taylor's "Medical Jurisprudence," p. 231 (Dr. Cox). Male: æt. 3. Small quantity of a strong solution.

	Result.—Death in 24 hours.	*Post-mortem.*—Death from suffocation, induced by inflammation of the larynx.

5.

"Medical Times and Gazette," 1853, p. 554, Nov. 26 (Dr. Barclay). Female: æt. 44. A quantity (?)

Symptoms.—Immediate vomiting; mouth and throat corroded; pain on swallowing; Death from starvation from inability to take food.	*Result.*—Death in 2 months.	*Post-mortem.*—Lower part of the gullet contracted, and lining membrane destroyed; muscular coat thickened and exposed; the lower opening of the stomach was so contracted as only to admit a probe; otherwise healthy.

6.

Taylor's "Medical Jurisprudence," p. 232. Male: adult. Quantity (?).

Symptoms.—Pain and vomiting.	*Result.*—Death in 4 months.	*Post-mortem.*—Stricture of the gullet.

7.

Taylor's "Medical Jurisprudence," p. 232 (Orfila). Two young men. ℥ss.

Symptoms.—Recovered from first symptoms.	*Result.*—(1) Death in 3 months. *Result.*—(2) Death in 4 months.	

8.

"Edinburgh Medical and Surgical Journal," xxx., p. 309 (Mr. Dewar). Male: boy. ℥iij of a strong solution.

	Result.—Death in 12 hours.	

9.

Beck's "Medical Jurisprudence," p. 524. Female: æt. 12. ℥ss.

Symptoms. Immediate; and continued uninterruptedly.	*Result.*—Death in 2 months.	

10.

Beck's "Medical Jurisprudence," p. 524. Female: æt. 16. ℥ss.

Symptoms set in directly, but abated after a few days. A relapse afterwards occurred.	*Result.*—Death in 3 months.	

(III.) NITRATE OF POTASH.

11.

"Orfila," i., 283. Female. ℥j.

Symptoms.—Vomiting in 15 minutes; pain in stomach; difficult breathing.	*Result.*—Death in 3 hours.	*Post-mortem.*—Stomach inflamed, and mucous membrane detached.

12.	"Orfila," i., 283. ℥ss.		*Result.*—Death in 60 hours.	*Post-mortem.*—Perforation found in stomach.
13.	Taylor's "Medical Jurisprudence," p. 237 (Dr. Geoghegan). Male: adult. ℥j—℥jss.	*Symptoms.*—Pain; vomiting; no purging.	*Result.*—Death in 2 hours.	*Post-mortem.* — Inflammation of stomach. None of the nitrate found after death.
14.	Casper's "Wochenschrift," 1841, No. 18. Male: adult. Two men swallowed ℥j by mistake.	*Symptoms.*—Vomiting, and bloody purging.	*Result.*—Recovery.	
15.	Casper's "Wochenschrift," 1841, No. 18. Male. ℥j.		*Result.*—Death in 36 hours.	
16.	Taylor's "Medical Jurisprudence," p. 238. Male: æt. 60. ʒx.	*Symptoms.*—Purging.	*Result.*—Death in 5 hours.	*Post-mortem.*—Signs of great irritation in the stomach.
17.	"Pharmaceutical Journal," Feb., 1846, p. 356. Female: æt. 28. ℥j. in two doses.	*Symptoms.*—Pain; vomiting; no purging; secretion of urine arrested.	*Result.*—Recovery.	
18.	"Provincial Medical Journal," Aug. 19, 1846, p. 382 (Mr. Gillard). Male: adult. ℥ij.	*Symptoms.*—Pain and sickness set in in five minutes; vomiting induced by mustard.	*Result.*—Recovery.	
19.	Taylor's "Medical Jurisprudence," p. 238 (Mr. Fuller). Male: adult. ℥j.	*Symptoms.*—Vomiting; no purging.	*Result.*—Death in 3 hours.	*Post-mortem.*—Stomach and duodenum much inflamed.
20.	"Medical Times and Gazette," Nov. 7, 1857, p. 481 (Mr. Davies). Female. ℥j in water.	*Symptoms.*—The following day seemed quite collapsed; vomiting; swollen abdomen; purging, with bloody stools.	*Result.*—Recovery.	
21.	"Medical Times and Gazette," Aug. 30, 1856, p. 220 (Dr. Deutsch). From "Berlin Zeitung," 1855, No. 49. Male: æt. 30. ʒvj at one dose, ℥jss having been taken previously in smaller doses.	*Symptoms.*—Insensibility after the ʒvj dose; tremblings; slight convulsions; hallucination of senses; partial paralysis of muscular action. Suffered for some time after from derangement of urinary and digestive organs.	*Result.*—Recovery.	

A Case of Poisoning by Nitrate of Potash is recorded in—
"British Medical Journal," Jan. 9, 1864, p. 56.

(IV.) SULPHATE OF POTASH.

22.

"Ann. d'Hygiène," April, 1842. Female: adult. ʒx taken as a laxative a week after delivery.

Symptoms.—Pain; nausea; vomiting; purging; cramps.	*Result.*—Death in 2 hours.	*Post-mortem.*—Mucous membrane of stomach and intestines pale; reddish-coloured liquid found in stomach.

23.

"Medical Times and Gazette," Dec. 30, 1843, p. 175; Taylor's "Medical Jurisprudence," p. 239 (Queen *v.* Haynes), Oct., 1843. Female: adult. ʒij. Given to induce miscarriage.

	Result.—Death in 1½ hours.	*Post-mortem.*—Stomach very inflamed; blood effused on the brain.

24.

"Medical Times and Gazette," Oct. 25. 1856, p. 420 (Queen *v.* Gaylor). Female: adult. ℥ij. To procure abortion.

Symptoms.—Severe irritation of stomach; pain; vomiting and purging.	*Result.*—Death.	*Post-mortem.*—Stomach inflamed.

See also Cases in "Mem. Acad. Nat. Cur.," 1862, from Gusellius; "Journal de Médecine," vol. lxii (Sobaux); "Journal de Pharmacie," March, 1843 (Moritz); "Medical Gazette," vol. xxxiii., p. 54.

(V.) TARTRATE OF POTASH.

25.

"Lancet," Oct. 28, 1837, p. 162 (Mr. Tyson). Male: æt. 37. At least ¼lb.

Symptoms.—Vomiting and purging; great pain and thirst set in in 24 hours; legs appeared paralysed; vomit of a blackish-green colour.	*Result.*—Death in 48 hours.	*Post-mortem.*—Stomach, duodenum, and rectum inflamed in patches; other viscera healthy.

(VI.) ALUM (SULPHATE OF ALUMINA).

26.

"L'Union Médicale," No. 64, 1873. Male: æt. 27. 50 grammes (= 1 oz. 5 dr.).

Symptoms.—Immediate burning sensation and feeling of constriction; nausea and vomiting; no diarrhœa; intense agony; intellect clear.	*Result.*—Death in 8 hours.	*Post-mortem.*—The whole of the digestive canal inflamed.

SODIUM.

(Na = At Wt 23.)

(Sp. Gr. 0·972: melts at 90·C).

Sodium is prepared by treating sodium carbonate ($Na_2 CO_3$) with carbon in a similar manner to that adopted in the preparation of potassium. It forms two oxides, $Na_2 O$ and $Na_2 O_3$.

Sodium Hydrate (Na HO = 40).

(Caustic Soda).

Caustic soda is obtained from the carbonate by the same method that is adopted in the preparation of caustic potash. It is a white solid, very soluble in water. The soda-ley (solution of the hydrate in water) boiled with fat or oil constitutes *hard soap.* The marine soap which is soluble in salt water is made from soda-ley and cocoa-nut oil.

Strength of Aqueous Solutions of Soda of various gravities.

Sp. Gr.	Per cent. of Na_2O.	Sp. Gr.	Per cent. of Na_2O.
1·428	30·22	1·194	12·69
1·375	26·59	1·163	10·87
1·327	22·96	1·123	8·46
1·298	20·55	1·094	6·64
1·277	18·73	1·067	4·83
1·257	16·92	1·033	2·41
1·228	14·50	1·016	1·20

The action of caustic soda on animal tissues is a little less energetic than that of potash. It has, however, not much interest medico-legally. The salts are colourless, and are all soluble in water.

Respecting the symptoms, post-mortem appearances, and treatment, what has been said of potash will apply equally to caustic soda (*see* Potash).

Tests: (*vide* page 93).

1. *Antimoniate of Potash.*

(The test solution must be prepared fresh each time it is required).

If the solution to be tested be acid, neutralize it first of all carefully with potash, and then add the test solution, when a white precipitate of antimoniate of soda will be produced.

Fallacy: The test produces a precipitate with many metallic oxides, the absence of which must first be proved.

No precipitate is given by it with ammonia or potash.

2. *Action of Polarized Light* ("Chemical Gazette," x. 378). The double platinum salt of soda at once restores light to the *dark* field of the polariscope.

Proceed as follows: After getting rid of all bases from your solution add hydrochloric acid and a small quantity of a solution of perchloride of platinum; evaporate until the salt begins to crystallize; arrange the apparatus so that the field of view is dark, that is, the analyzer being at right angles to the polarizer. Immediately the crystals containing the sodium salt are placed in the field, light will be restored, and a play of colour observed. Neither the potassium salt nor the platinum salt alone possess this power. It is said that the 1-825,000 gr. of Na_2O may be thus detected.

3. *Picric or Carbazotic Acid.*

Produces a yellow precipitate of radiating feathery crystals.

4. All sodium salts heated on platinum:

1st. Leave a fixed residue, which is generally fusible.
2nd. The least trace of this residue gives a yellow colour to flame.
3rd. Examined with the spectroscope it produces a yellow band at the D line of the spectrum.

For recovery of caustic soda from organic mixtures in toxicological examinations, *vide* Potash.

Sodic Carbonate (= $Na_2 CO_3 + 10 H_2O = 106 + 180$).

(Common washing soda: Scotch soda: Soda. Soap-lees.)

This was formerly made from the ashes of sea-weeds. *Land* plants contain potash salts and their ash $K_2 CO_3$, *sea* plants contain soda salts and their ash $Na_2 CO_3$. This ash (kelp, barilla, or varec) is now used for the extraction of the iodine, and not for the carbonate of soda, which is ordinarily prepared from common salt by the process of Leblanc.

It consists of large efflorescent crystals, melting when heated in their water of crystallization. If the heat be furthur continued, anhydrous sodium carbonate remains. It is very soluble in water, insoluble in alcohol, and has a disagreeable taste. It is strongly alkaline to test paper.

Commercial soda ordinarily contains sulphuric acid and chlorine, and occasionally hyposulphurous acid, sulphide and cyanide.

Common soda is largely sold by oilmen for cleansing purposes. It acts as an irritant poison.

Hydric Sodic Carbonate ($Na H CO_3 = 84$).

(Bicarbonate of Soda.)

This is prepared by exposing crystals of the carbonate to the action of carbonic acid gas. It is less soluble in water than sodic carbonate.

Sodium Chloride ($Na Cl = 58{\cdot}5$).

(Common Salt).

Common salt is found native and may also be obtained from natural springs and from sea water (= bay salt).

In large quantities it acts as an irritant poison.—Appropriate treatment for irritant poisoning must be adopted.

Sodium Sulphide.

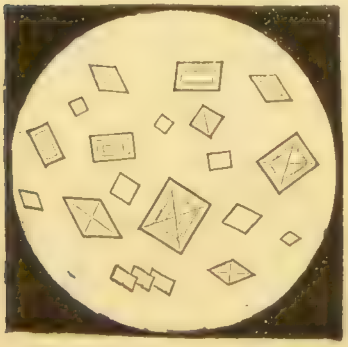
Vide Potassium Sulphide.

Sodium Nitrate ($Na NO_3$).

(Cubic Nitre or Chili Saltpetre, fig. *g*.)

Vide Potassium Nitrate.

FIG. *g*.



Crystals of Nitrate of Soda magnified 30 diameters.

Cases of Poisoning by Sodium and its Salts.

(I.) CAUSTIC SODA.		
1. See "Lancet," Nov. 3, 1866, p. 508.		
(II.) CARBONATE OF SODA.		
2. "Lancet," March 2, 1850 (Dr. Barham). Soap lees.		
	Result.—Died; aged 2¼ years.	*Post-mortem.*—Stricture of œsophagus.
3. "Medical Times," Nov. 30, 1850, p. 564 (Dr. Tunstall). Male. Took ℥ij for 16 years daily.		
Symptoms.—Dr. T. traces this death to the drug.	*Result.*—Died suddenly.	*Post-mortem.*—Stomach very diseased.
4. "Medical Times and Gazette," Aug. 13, 1864, p. 187. Female. About ¾ of a pound of common washing soda taken in water.		
Symptoms.—Great pain, rigors, and headache; difficulty in passing water; and great thirst. Nausea. Urine very alkaline for several days.	*Result.*—Recovery.	
(III.) CHLORIDE OF SODIUM.		
5. "Medical Times," vol. i., Jan. 4, 1840, p. 133. ½lb.		
Symptoms.—Paralysis.	*Result.*—Death.	

AMMONIUM.

(H_4 N = 18).

The existence of the compound radical ammonium is only as yet assumed. We regard it (H_4 N) as a compound metal just as we regard cyanogen (C N) as a compound halogen.

Ammonia gas ($NH_3 = 17$) is set free by heating two parts of sal-ammoniac (NH_4 Cl) with three of well slaked lime.

$$2\,(NH_4\,Cl) + CaO,\,H_2\,O = 2\,(NH_3) + Ca\,Cl_2 + 2\,(H_2\,O).$$

To form the liquor ammoniæ the gas is passed into water which dissolves at 0° Cent. more than 1000 times, and at 17° Cent. about 700 times its bulk. It has a sp. gr. of 8·5. It has a very pungent smell and an exceedingly corrosive action on animal tissues. It turns red litmus blue, but the original colour in time comes back. It is therefore a volatile and not a fixed alkali. It can be made to burn, although with great difficulty. It is decomposed by the electric spark, and also by passing it through a red hot tube, the decomposed gases occupying double the space of the undecomposed gas. It can be liquefied by a pressure of 6 atmospheres at 10° Cent.

Ammonia gas is a constituent of the atmosphere, and is given off when animal and vegetable substances containing nitrogen undergo putrefaction. It is further produced in large quantities during the manufacture of coal gas.

Solution of Ammonia.

(Spirits of Hartshorn—Aqua Ammoniæ—Liquor Ammoniæ).

This solution may be regarded as ammonium hydrate ($[H_4 N] HO$). It is largely used both in the arts and in medicine. When pure it is colourless, and leaves no residue when evaporated to dryness. The gas is given off freely when the solution is heated. It has a pungent smell, and a powerful alkaline reaction.

Table showing the per-centage of Ammonia (NH_3) *in liquids of various gravities.*

Sp. Gr.	Per cent. of NH_3.	Sp. Gr.	Per cent. of NH_3.
0·875	32·30	0·938	15·88
0·885	29·25	0·943	14·53
0·900	26·00	0·947	13·46
0·905	25·37	0·951	12·40
0·916	22·07	0·954	11·56
0·925	19·54	0·959	10·17
9·932	17·52	0·963	9·50

The salts of ammonia are colourless, and volatile by heat, whilst all (excepting the acid tartrate) are freely soluble in water. They are decomposed and ammonia gas set free by the action of heat applied in the presence of the fixed caustic alkalies.

Symptoms : Dose, &c.

If *the solution* of the gas be administered, the symptoms produced are very similar to those resulting from the action of soda and potash, excepting in two particulars, (1) that the symptoms are more severe, and (2) that dyspnœa, which is not a very prominent symptom with the fixed alkalies, is always very intense in ammonia poisoning. After the active stage has passed away there is a better chance of recovery than with either potash or soda.

In the form of *vapour* it has produced intensely severe effects, such as violent dyspnœa, pain, suffocation, with extreme irritation of the larynx, lungs, and air passages. Even its indiscriminate use for rousing persons from fainting fits has been accompanied with bad results.

Death has taken place in as short a time as four minutes, whilst it has been delayed for nineteen days and even three months. Cases of death are on record in four and five hours, and in two, three, and four days.

As regards *quantity*, two drams of the strong solution has proved fatal. Half-an-ounce is usually a poisonous dose, but recovery is recorded after 1oz. One of the authors has met with three or four cases of recovery after three or four drams of liquid ammonia.

Post Mortem Appearances.

These are similar to those produced by potash and soda (page 92); an extremely fluid state of the blood, fatty changes in the liver and kidneys, and softness of the spleen have been specially noticed.

Treatment.

The *treatment* to be adopted must be similar to that recommended for potash and soda. In poisoning by the vapour, the inhalation of acetic or dilute hydrochloric acid constitutes the most appropriate treatment.

The action of the *tetra-methyl of ammonium* has of late been investigated by M. Rabuteau; $\frac{1}{6}$th of a grain killed a frog in five minutes, and ten grains killed a dog in a few hours.

Tests for Ammonia and its Salts.

1. Ammonia salts are known—

   (*a*) By their being entirely dissipated when heated on platinum foil, unless a fixed acid or foreign matter be present.

   (*b*) Treated either with lime, caustic potash or soda, and heated, free ammonia is given off. This is known—

      1. By its odour.
      2. By its action on turmeric paper.
      3. By white fumes being produced ($NH_4\ Cl$) when a rod moistened with hydrochloric acid is brought near.

2. *Perchloride of Platinum.*—In neutral or slightly acid solutions, a yellow crystalline precipitate of ammonio-chloride of platinum ($2\ NH_4Cl,\ Pt\ Cl_4 = 446{\cdot}4$), sparingly soluble in dilute mineral acids, or in free alkalies, is produced.

Fallacy. The precipitate is very similar to the potash precipitate. To distinguish them, *vide* page 94.

No precipitate is produced when the platinum chloride is added to solutions of sodium salts.

3. *Tartaric Acid.*—In neutral solutions, if they be not very dilute, a white crystalline precipitate of tartrate of ammonium ($NH_4\ H_5\ C_4\ O_6 = 167$), soluble in alkalies and in dilute mineral acids, is produced.

4. *Picric Acid* (alcoholic solution).

Gives in neutral solutions a yellow crystalline precipitate soluble in excess.

5. *Nessler's Solution.*

This test is exceedingly delicate. It consists in the addition of an excess of iodide of potassium to a solution of mercuric chloride ($Hg\ Cl_2$), until the mercuric iodide formed is redissolved, an excess of free potash being added.

Preparation : Dissolve 550 grs. of iodide of potassium in 5 oz. of water, and 220 grs. of corrosive sublimate in 5 oz. of water, and 900 grs. of potash in 5 oz. of water. Add the iodide of potassium solution to the corrosive sublimate solution, then add the potash solution, and make up to 20oz. with water. Allow the solution to settle, and decant when clear.

This liquid gives a brown discoloration with the merest trace of ammonia, a hydrargyro-iodide of ammonium being said to be formed. The reaction does not take place in the presence of cyanides, and it is also influenced to an extent by an excess of chlorides.

6. *Phospho-Molybdate of Soda* (Sonnenschein).

Gives a yellow precipitate of phospho-molybdate of ammonia. It constitutes a very delicate test for ammonia. A similar precipitate is produced with potash, but not with soda salts.

Toxicological Analysis.

If the organic matter is in a state of decomposition it will be very little good attempting to recover the ammonia that has been the cause of death, for not only is ammonia volatile, but is itself produced by decomposing organic matters.

If only ammonia or the carbonate be present, the liquid will have an ammonia odour and an alkaline reaction. Distil over about one-fourth of the organic liquid, conducting the vapours through a bent tube into a well cooled receiver containing a little water acidulated with hydrochloric acid. If no ammonia be given off in this way, proceed to examine the materials for other ammonia salts.

To do this, Wormley advises to act on the residue in the retort with strong alcohol. Filter. Treat the filtrate with caustic potash and distil as before. Test the acid solution for ammonia by the several tests.

Ammonia is estimated quantitatively either by the Nessler test, or as ammonio-chloride of platinum (*see* Potash).

$$100 \text{ grs.} = 7{\cdot}62 \text{ of } NH_3.$$
$$\text{,,} \quad = 15{\cdot}68 \text{ of } (H_4 N)HO.$$

Sesqui-Carbonate of Ammonia ($2\,[2\,(H_4 N)CO_3]\,CO_2 = 236$).

(Smelling Salts. The Solution is called Sal-Volatile).

It is prepared by heating chalk with about half its weight of powdered sal-ammoniac and subliming. Much free ammonia is generated during the process.

$$6\,H_4 N\,Cl + 3\,Ca\,CO_3 = 3\,Ca\,Cl_2 + 2\,[2\,(H_4 N)\,CO_3]\,CO_2 + 2\,H_3 N + H_2 O.$$

It is very volatile, having an ammonia smell, and becomes a bicarbonate when exposed to air. It is soluble in cold water.

The symptoms and post-mortem appearances are the same as those already described (*see* Potash).

Death has been both rapid and delayed.

Tests (*vide* page 106).

It may be known—

1. From *Carbonates of Soda and Potash;* by its being volatile, by its giving no precipitate with sulphate of magnesia, and by its turning a sulphate of copper solution a deep blue.
2. From *other Carbonates;* by its odour, alkalinity and volatility.
3. From *Ammonia;* by effervescing with an acid, and by giving a white precipitate with chloride of calcium.

Chloride of Ammonium (NH_4 Cl.)
(Sal Ammoniac).

It consists of colourless crystals, soluble both in water and in alcohol. It is generally made from the ammoniacal liquor of gas works by neutralizing it with hydrochloric acid.

One case of poisoning by its action is recorded.

Cases of Poisoning by Ammonia and its Salts.

<table>
<tr><th colspan="3">(I.) AMMONIA.</th></tr>
<tr><td colspan="3">1.
Taylor's "Medical Jurisprudence," p. 233. Vapour used to rouse the patient, who was an epileptic.</td></tr>
<tr><td><i>Symptoms.</i>—Croup.</td><td><i>Result.</i>—Death in 2 days.</td><td></td></tr>
<tr><td colspan="3">2.
"Christison," p. 194. Male. Adult. Solution.</td></tr>
<tr><td></td><td><i>Result.</i>—Death in 4 minutes.</td><td></td></tr>
<tr><td colspan="3">3.
"Journal de Pharmacie," Oct., 1846, p. 285. ʒj—ʒij liq. ammoniæ.</td></tr>
<tr><td><i>Symptoms.</i>—Vomiting and bloody purging.</td><td><i>Result.</i>—Death.</td><td><i>Post-mortem.</i>—Blood effused in intestines; blood very fluid.</td></tr>
<tr><td colspan="3">4.
"Journal de Chimie Médicale," 1845, p. 531. Male. ʒiss of liq. ammoniæ.</td></tr>
<tr><td><i>Symptoms.</i>—Fell down instantly insensible.</td><td><i>Result.</i>—Death.</td><td></td></tr>
<tr><td colspan="3">5.
Taylor's "Medical Jurisprudence," p. 234 (Mr. Hilton). Male: adult. Liq. ammoniæ.</td></tr>
<tr><td><i>Symptoms.</i>—Symptoms immediate from local irritation; great difficulty of breathing.</td><td><i>Result.</i>—Death in 3 days.</td><td><i>Post-mortem.</i> — Corrosion in various parts, with perforation of stomach: stomach very congested. None of the poison found.</td></tr>
<tr><td colspan="3">6.
"Edinburgh Medical Journal," 1857, vol. ii., p. 236 (Dr. Patterson). Male: æt. 40. ℥ij of liq. ammoniæ or carbonate (?).</td></tr>
<tr><td><i>Symptoms.</i>—Pain and instant vomiting; difficult breathing.</td><td><i>Result.</i>—Death in 19 days.</td><td></td></tr>
</table>

7.

"American Journal of Medical Science," Jan., 1870, p. 275 (Dr. Kerr). Male: æt. 70. Two mouthfuls of liq. ammoniæ.

Symptoms.—Immediate suffocation and vomiting.	*Result.*—Death in 4 hours.	*Post-mortem.*—Great general congestion; lining membrane of mouth, throat, &c., destroyed.

8.

"Lancet," 1870, vol. i., p. 467. Male. ℥ss of liq. ammoniæ.

	Result.—Death in 5 hours.	

9.

Taylor's "Medical Jurisprudence," p. 235 (Mr. Tyerman). Male: æt. 62. ℥ij of lin. camph. co. and liq. ammoniæ=℥ijss.

Symptoms.—Lost the power of swallowing from inflammation.	*Result.*—Recovery in 4 days.	

10.

Taylor's "Medical Jurisprudence," p. 235 (Mr. Gill). Infant four days old. Small quantity of lin. camph. co.

Symptoms.—Pain; clenched hands; difficulty in swallowing and breathing.	*Result.*—Death in 32 hours.	

11.

"Lancet," April 4, 1846, p. 385 (Mr. E. P. Wilkins). Female: æt. 24. A strong solution.

Symptoms.—Immediate insensibility; great pain; voice became a mere whisper; choking sensation on swallowing; convulsions. Recovered in a fortnight.	*Result.*—Recovery.	

12.

"Medical Times and Gazette," Oct. 8, 1864, p. 385 (Dr. Woodman). Female: æt. 18. ℥j of the strongest solution.

Symptoms.—Instant vomiting. In four hours tongue, lips, and tonsils appeared white in patches, and stripped of epithelium; pupils dilated; great headache: pain in throat and stomach; glands of neck swollen and tender; great tendency to syncope. Urine became scanty and dark-coloured.	*Result.*—Recovery.	

13.

"Medical Times and Gazette," Aug. 2, 1862, p. 118 (M. Potain). Male: æt. 44. ℥iij of liq. ammoniæ = 100 grammes.

Symptoms.—Immediate symptoms of suffocation; pain and prostration; bloody vomiting and purging; difficulty of swallowing.	*Result.*—Death in 10 days.	*Post-mortem.*—Larynx and pharynx of a bright red colour; œsophagus ulcerated; stomach natural, excepting an ulcer at the cardiac orifice; intestines natural; kidneys fatty.

14.

"Medical Times and Gazette," July 21, 1865, p. 59 (Dr. Wilson Reed). Male: æt. 35. Liniment of liq. am. fort ʒiij, amm. carb. ʒiij, ol. olivæ ℥ij.

Symptoms.—Immediate burning pain in throat and stomach; loss of speech; bloody secretion from mouth and nares; profuse perspiration; vomiting; insensibility in 3 hours; urine said to have been bloody; extreme inflammatory symptoms set in. No difficulty in swallowing.	*Result.*—Recovery.	

15.

"Med. Chi. Contralblatt," July 4, 1873 (Dr. Winter). Male: æt. 28. ʒiij of strong liq. ammoniæ.

Symptoms.—Skin pale and cold; early vomiting; intellect clear; pupils widely dilated; mouth and throat swollen and tender; laryngeal symptoms not severe, but the voice weak and hoarse; great pain along the œsophagus, but not in the stomach; no abdominal distension; great quantity of urates found in urine the following day. No action of bowels for five days. (Vinegar, ice, and clear cold soups given.)	*Result.*—Recovery.	

16.

"Med. Chi. Monatshefte," p. 493, Jan., 1857. Male. ℥j.

Symptoms.—Severe laryngeal symptoms, profuse salivation, and great general emaciation.	*Result.*—Recovery.	

17.

"Guy's Hospital Reports," 3rd series, xvii., p. 225 (Dr. Stevenson). A teaspoonful of strong liq. ammoniæ, sp. gr. 0·88.

Symptoms.—No asphyxia.	*Result.*—Death suddenly.	

18.

"Taylor's Medical Jurisprudence," p. 236. Male: adult. ʒv of a solution.

Symptoms.—In 10 minutes stupor came on. Suffered for some time after from irritation about the throat.	*Result.*—Recovery.	

19.

"Medical Times and Gazette," Nov. 26, 1853, p. 554 (Dr. Barclay). Female: æt. 19. A quantity of hartshorn.

Symptoms.—Vomiting of blood; irritability of stomach; constipation.	*Result.*—Death in 3 months.	*Post-mortem.*—Gullet healthy; cardiac orifice of stomach slightly contracted, and the intestinal orifice contracted to size of crowquill.

20.

Taylor's "Medical Jurisprudence," p. 236 (Dr. Proctor). Infant: four weeks. A teaspoonful of hartshorn.

Symptoms.—No vomiting or purging; no excoriation of mouth or throat.	*Result.*—Death in 36 hours.	

21.

"Lancet," Dec. 1, 1849, p. 575 (Mr. Iliff). Male: æt. 2. ʒiv spirits of hartshorn merely taken into the mouth.

Symptoms. — Immediate vomiting; croupy breathing; probably none went into the stomach.	*Result.*—Recovery.	

22.

"Lancet," March 13, 1852, p. 261 (Mr. Trotter). Male: 36. ℥j of hartshorn in milk by mistake for castor oil.

Symptoms.—Vomiting; great pain; lips and mouth excoriated and white. No diarrhœa.	*Result.*—Recovery in 2 days.	

For other Cases of Poisoning by Ammonia and the Fumes, see—

"Lancet," Feb. 10, 1866, p. 162; "Ann. d'Hygiène," Jan., 1841 (vapour).
"Medical Times," Dec. 5, 1840, p. 112 (from the vapour); "Medical Times and Gazette," May 26, 1855 (liniment).
"Montpellier Med.," Nov., 1871, p. 527 (poisoning from the fumes).

(II.) CHLORIDE OF AMMONIUM.

23.

"Lancet," June 6, 1868, p. 720 (Dr. C. Browne). Male: æt. 25. A quantity taken during six hours.

Symptoms.—No symptoms for at least two hours after the last dose; afterwards giddiness; staggering; pain in stomach; delirium; convulsions; pupils normal. The following day he seemed for a time better, but bad symptoms came on. An hour afterwards he was reported dead. The medical officer detected a flutter of the pulse, and commenced vigorous measures for resuscitation. After a time convulsions came on, and opisthotonos, then muscular relaxation, and consciousness in about 15 minutes. Delirium returned in 1 hour. He was unable to pass water; and, with some symptoms of drowsiness and delirium, he made a perfect recovery by the following morning.	*Result.*—Recovery.	

LITHIUM—RUBIDIUM—CŒSIUM.

As regards lithium, rubidium, and cœsium, they are no doubt poisons, but from their extreme rarity are of little interest to the medical jurist. The use of lithium in medicine in cases of gout depends on the fact that it forms with uric acid a very soluble salt, a very small quantity only being needed to keep in solution a large quantity of the acid. In this way uric acid may be got out of the system (for lithia is itself a diuretic), and its deposition prevented.

CHAPTER IX.

METALS OF THE ALKALINE EARTHS AND THEIR SALTS.

Barium.—Symptoms, &c.—Experiments on Animals.—Tests.—Cases of Poisoning.—*Strontium.*—*Calcium.*

Barium (Ba); *Strontium* (Sr); *Calcium* (Ca).

The oxides of these metals are called alkaline earths, viz., Baryta (BaO); Strontia ($Sr\,O$) and Lime ($Ca\,O$). They are all nearly insoluble in water.

The metals of the alkaline earths differ from the metals of the alkalies in the following respects:—

1. They are divalent, the alkaline metals being univalent.
2. They are all heavier than water, the alkaline metals being lighter.
3. They decompose water much less rapidly.
4. Their carbonates are insoluble in pure water, but soluble when the water contains carbonic acid in solution.

BARIUM ($Ba = 137$; sp. gr. 4·00.)

Barium is but little known in a free state. Both it and its soluble salts are very poisonous.

Barium Compounds.

Baryta ($Ba\,O = 153$) is prepared by heating nitrate of baryta ($Ba\,2NO_3$) in a crucible to redness. It combines with water very energetically, forming—

Barium Hydrate ($Ba\,O,\,H_2O) = 171$) (Crystals $BaO,\ H_2O + 8H_2O = 171 + 144$). The hydrate is soluble in twenty parts of cold and in three parts of hot water.

Barium Sulphate ($Ba\,SO_4 = 233$). The sulphate is very insoluble, and it is doubtful whether it is a poison. It is called heavy spar and is used as a substitute for, and an adulterant of white lead (permanent white).

Barium Chloride ($Ba\,Cl_2 = 208$). (Crystals $= Ba\,Cl_2, 2\,H_2O = 208 + 36$.) The chloride crystallizes in thin pearly plates. It is insoluble in absolute alcohol.

Barium Nitrate ($Ba,\,2\,NO_3 = 261$) is largely used in pyrotechny. When heated $Ba\,O$ is left.

Barium Carbonate ($Ba\,CO_3 = 197$) *Witherite.* It is insoluble in water, but is easily soluble in the acid juices of the stomach. It is used as a rat poison. A dram is said to be a fatal dose.

Symptoms; Dose, &c.

The symptoms produced by Baryta and its salts are those of an irritant poison. Great pain in the stomach and bowels, a heaving palpitation of the heart, with purging and vomiting, are the prominent symptoms.

Towards the close of the case, brain and nervous symptoms usually occur, such as giddiness, cramps, paralysis, and violent convulsions.

Death has resulted from one dram of the chloride, whilst bad symptoms were produced in one case by less than three grains given in divided doses. A case is recorded of poisonous symptoms being produced in a child by its sucking a paper collar that had been stiffened with sulphate of Baryta (?) ("British Medical Journal," Feb. 8, 1868, p. 136).

Death has occurred in one hour and been delayed for seventeen.

Post-Mortem Appearances.

Those recorded in the human subject are very similar to what have been observed as having occurred in animals. The effects in the main are those of an irritant poison. In a case coming under the observation of one of the authors there was great congestion of the brain and its membranes, both sides of the heart were full of black blood, and the lungs much inflamed. The stomach as well as the duodenum showed signs of considerable inflammatory action. Perforation has in one case been recorded. The remainder of the intestines were not in the case referred to inflamed until the rectum was reached, and this was found to be in a state of great congestion.

Orfila has pointed out that the salts of barium are quickly absorbed, and may be detected after death in the liver, spleen, and kidneys.

Treatment.

The treatment consists in the free administration of the soluble sulphates, such as those of sodium and magnesium. The stomach pump may be used if the case be seen early, and emetics must be given freely.

Experiments on Animals.

The following is a tabulated list of the results obtained by several investigators:—

Dose.	Animal.	Symptoms.	Results.	Post-mortem.
10 grains of Nitrate of Baryta (Tidy and Woodman).	Rabbit (by mouth.)		Death in 1 hour.	Pupils dilated. Brain, liver, and lungs congested. Stomach rotten and inflamed. Rectum very congested.
5 grains of Nitrate of Baryta (Tidy and Woodman).	Rabbit (by mouth).	Convulsions in 2 hours. Violent purging. Pupils dilated.	Death in 26 hours.	Brain normal. Stomach inflamed and very rotten. Lungs and liver congested. Rectum very congested. No apparent change in the small intestines.
30 grains of Nitrate of Baryta (Tidy and Woodman).	Small terrier (by mouth).	Insensible in 2 hours, with vomiting, purging and convulsions. Pupils dilated.	Death in about 4 hours.	Brain normal. Lungs, liver, stomach, and duodenum congested. Rectum intensely so.

Dose.	Animal.	Symptoms.	Results.	Post-mortem.
10 grains of Nitrate of Baryta (Tidy and Woodman).	Dog (by mouth).	No marked symptoms for 17 hours, when convulsions, vomiting, and purging occurred. In 28 hours paralysis.	Recovered in 4 days.	
20 grains of Nitrate of Baryta (Tidy and Woodman).	Dog (by mouth).	Vomiting and purging in 3½ hours. Convulsions in 6 hours.	Recovered in 2 days.	
30 grains of Nitrate of Baryta (Tidy and Woodman).	Dog (by mouth).	In 22 hours convulsions and purging.	Recovered in 3 days.	
60 grains of Nitrate of Baryta (Tidy and Woodman).	Large dog (by mouth).	In 8 hours convulsions and purging--passed a large quantity of water. In 23 hours paralysis of hind legs.	Recovered in 2 days.	
120 grains of Nitrate of Baryta (Tidy and Woodman).	Large dog (by mouth).	Convulsions, purging, and vomiting in 1 hour. Great thirst; passed a large quantity of urine.	Death in 2½ hours.	Brain normal; lungs, liver, kidneys, stomach, and all the intestines, but especially the rectum, deeply congested. Bladder empty.
5 grains of Chloride of Barium (Orfila).	(Injected into veins of a dog).	Convulsions.	Death in 6 minutes.	
10 grains of Chloride of Barium (Brodie).	Applied to a wound on the back of a rabbit.	Convulsions, palsy, coma.	Death in 20 minutes.	
3 grains of Chloride of Barium (Brodie)	Cat (by mouth).		Death in 1 hour.	
ʒij of Chloride of Barium (Huzard and Biron).	Horse (by mouth).		Death in 15 days.	
℥ij of Carbonate of Baryta (Campbell).	Dog (by mouth).		Death in 6 hours.	
15 grains of Carbonate of Baryta (Campbell).	Dog (by mouth).		Death in 15 hours.	
12 grains of Carbonate of Baryta (Campbell).	Applied to a wound on the neck of a cat.	Convulsions.	Death.	

Experiments prove that Baryta (as happens with most irritant poisons) has a double action, the one *local* and the other *remote.* The usual symptoms are convulsions, excessive purging and vomiting, great thirst, dilated pupils, with frequent and excessive micturition and paralysis. The marked post-mortem appearances are persistent rigor mortis, distension of both sides of the heart with black blood, congestion of the lungs, liver, and kidneys, congestion and extreme rottenness of the stomach, and sometimes of the whole intestines, but invariably intense inflammation of the rectum.

Tests for the Salts of the Metals of the Alkaline Earths.

Note: There are certain properties that barium, strontium, and calcium salts have in common.

1. Their sulphides and sulphydrates are all soluble; therefore, they are not precipitated by sulphuretted hydrogen, or by sulphide of ammonium.

2. Their oxalates, phosphates, and carbonates are insoluble in water. They can all therefore be precipitated by a soluble carbonate.

3. They are all precipitated by sulphuric acid and the soluble sulphates. *Sulphate of baryta* is absolutely insoluble in water—*sulphate of strontia* nearly insoluble in water, and *sulphate of calcium,* only soluble to the extent of 1 grain in 1 oz. of water.

4. A white fixed residue is left when any of their salts are ignited.

Tests for Barium and its Salts.

1. *Sulphuric acid* and *solutions of all sulphates* give a white precipitate of sulphate of barium ($Ba\ SO_4 = 233$) which is insoluble either in acids or alkalies. Always before testing acidulate the solution with nitric acid, or otherwise the white precipitate may be a carbonate, phosphate, or oxalate of barium.

2. Heated on platinum wire in a colourless Bunsen flame or before the blow-pipe, they impart a green colour to the flame.

3. In neutral and acid solutions, *hydrofluosilicic acid,* gives a precipitate of fluosilicate of barium ($Ba\ Si\ F_6$). The acids of the several salts must be recognised by their several re-actions.

Toxicological Analysis.

Filter the contents of the stomach.

(*a*) *Filtered liquid.*

Add dilute sulphuric acid, boil and filter. Ignite the filter paper so as to burn away the organic matter. Boil the residue with water, acidulated with sulphuric acid, and again filter and weigh. Every 100 grains indicate 65·66 of baryta. This indicates the quantity of soluble baryta salt present.

(β) *Residue on filter.*

Boil with carbonate of soda, filter, and wash the residue with distilled water, acidulated with hydrochloric acid. Test the filtrate for baryta as in the preceding case.

Cases of poisoning by the Salts of Baryta.

<table>
<tr><th colspan="3">(I.) CHLORIDE OF BARIUM.</th></tr>
<tr><td colspan="3">1.
"Lancet," Feb. 26, 1859, p. 211 (Mr. Walsh, Manchester). Female: æt 22. A teaspoonful (about ʒj) in water.</td></tr>
<tr><td><i>Symptoms.</i>—In half-an-hour severe pain, vomiting and purging set in. In 1½ hours muscular power of extremities almost gone, intelligence not impaired, respiration slow and laboured. In eight hours symptoms seemed to abate, but returned with coma after 14 hours. Convulsions occurred 2 hours before death, and continued without intermission until death.</td><td><i>Result.</i>—Death in 17 hours.</td><td></td></tr>
<tr><td colspan="3">2.
"Ann' d' Hyg'," 1841, 2, 217. ℥j taken in mistake for glauber salt.</td></tr>
<tr><td><i>Symptoms.</i> — Vomiting, convulsions, headache, deafness.</td><td><i>Result.</i>—Death in 1 hour.</td><td></td></tr>
</table>

3.

"Christison," p. 580 (Dr. Wach). Female: adult. ℥ss by mistake for sulphate of soda.

Symptoms.—Sickness, convulsions, loss of voice, faculties clear to the last.	*Result.*—Death	*Post-mortem.*—Stomach very inflamed externally and internally; perforation near the cardiac end; small intestines inflamed; large intestines contracted; lungs and brain gorged.

4.

"Medical Times," March 28, 1845, p. 508 (Dr. Ferguson, from the "Dublin Journal of Medical Science). Female. $\frac{1}{12}$ gr. three times a day (about 2¼ grains altogether).

Symptoms.—In a week extreme exhaustion came on, and severe nervous symptoms.	*Result.*—Recovery.	

(II.) NITRATE OF BARYTA.

5.

"Pharmaceutical Journal," June, 1872, p. 1021; "Medical Press and Circular (Dr. Tidy and Mr. Kennedy). Male: æt. 46. Considerable quantity given in mistake mixed with sulphur.

Symptoms.—Symptoms immediate. Intense pain in stomach, loss of voice, vomiting, purging, convulsions.	*Result.*—Death in 6½ hours.	*Post-mortem.*—Great congestion of the viscera. Of the intestines, only the duodenum and the rectum affected.

(III.) CARBONATE OF BARYTA.

6.

"Medical Gazette," vol. xiv., p. 448 (Dr. Wilson). Female. Half a tea-cup in water taken fasting.

Symptoms.—In 2 hours weight at stomach, dimness of sight, pain in head, cramp in legs, vomiting, severe palpitations.	*Result.*—Recovery.	

(IV.) ACETATE OF BARYTA.

7.

"Medical Times and Gazette," Jan. 31, 1874, p. 134. Male: æt. 40. A considerable quantity.

	Result.—Death.	

STRONTIUM (Sr. = 87·5; sp. gr. 2·5).

The nitrate of strontium is largely used in firework manufacture. All the compounds are more or less poisonous. We are indebted for experiments with the strontium salts to Pelletier, Blumenbach, Gmelin, and Blake. A rabbit died from the effects of half-an-ounce of the chloride of strontium given internally, a smaller dose producing no effect. Two drams of the carbonate and two of the nitrate given to rabbits, merely caused a slight diarrhœa. Ten grains of the chloride injected into the jugular vein of a dog produced no results, but forty grains arrested the heart's action in fifteen seconds.

Tests.

1. The *Soluble Carbonates* give white insoluble precipitates, soluble in hydrochloric acid, and in water containing carbonic acid.

2. *Dilute Sulphuric Acid* and *Soluble Sulphates* give a white precipitate of sulphate of strontia ($Sr\ SO_4$), insoluble in dilute acids. The precipitate being somewhat soluble in water, does not form immediately the test solution is added.

3. Strontium compounds when heated render the flame of a carmine red colour.

CALCIUM ($Ca = 40$; sp. gr. 1·6).

One case of death from lime is recorded. A man was ordered by his physician to drink some lime water. He thereupon procured a lump of lime, put it into water, stirred it up, and drank the thick liquid. Death occurred in a few hours.—("Medical Times and Gazette," Feb. 4, 1871, p. 13.) Lime is a caustic and irritant poison. In cases of poisoning the soluble sulphates should be administered. It should be remembered that lime is a natural constituent of various tissues.

Tests for Salts of Lime.

1. The *Soluble Carbonates* give white insoluble precipitates of calcium carbonate ($Ca\ CO_3$).

2. *Dilute Sulphuric Acid* gives, in concentrated solutions only, a white precipitate of sulphate of lime ($Ca\ SO_4$) slightly soluble in water.

3. *Oxalate of Ammonia* gives a white precipitate of oxalate of lime ($Ca\ C_2\ O_4$), soluble in hydrochloric acid. The delicacy of this test is increased by the previous addition to the solution of a little free ammonia. A similar precipitate is produced with baryta and strontia.

4. Lime compounds, heated in the inner blowpipe flame, give an orange red colour to the outer flame. Insoluble salts should be first moistened with hydrochloric acid before placing them in the flame.

CHAPTER X.

THE METALS.

ANTIMONY—Tartar emetic; properties, symptoms, treatment, &c.—Chronic antimonial poisoning—Experiments on animals—Tests—Quantitative estimation—Toxicological analysis—Chloride of antimony; properties, &c.—Cases of poisoning—*Arsenicum*, Arsenic—Preparation—Uses—Properties—Solubility—Symptoms, &c.—Treatment—Post-mortem appearances—Chronic arsenical poisoning—Tests—Toxicological analysis—Various processes—Arsenic acid—Arsenite of copper—Its use for wall papers, &c.—Tests—Orpiment—Realgar—Chloride of arsenicum—Arseniurretted hydrogen—Iodide of arsenicum—*Bismuth—Cadmium—Cerium—Chromium*—Bichromate of potash—Chronic poisoning—*Cobalt—Copper*—Red oxide—Black oxide—Sulphate—Sulphide—Nitrate—The acetates—Symptoms—Experiments upon animals—Chronic copper poisoning—Action of water and of articles of food on copper vessels—Tests—*Gold—Iridium and rhodium—Iron—Lead*—Carbonate of lead and other salts—Symptoms—Action on animals Treatment—Chronic lead poisoning—Action of water on lead—Action of acids on lead—Post-mortem appearances—Tests—Toxicological analysis—*Manganese—Mercury*—Corrosive sublimate—Symptoms—Treatment—Chronic mercurial poisoning—Experiments on animals—Post-mortem appearances—Tests—Toxicological analysis—Calomel—White precipitate—Red precipitate—Turpeth mineral—Vermilion—Nitrates—Cyanide and Sulphocyanide of mercury—Mercuric methide—*Molybdenum—Nickel—Osmium—Palladium Platinum—Silver—Thallium—Tin—Titanium—Tungsten—Uranium—Zinc*—Oxide—Carbonate—Chloride—Sulphide—Sulphate—Acetate—Symptoms, &c.—Experiments on animals—Tests—Toxicological Analysis.

ANTIMONY (Sb = 122).

(Sp. gr. 6·71; fuses at 430° C.)

ANTIMONY is usually prepared from the grey antimony ore (black sulphide). It is a bluish-white, very brittle, laminated, crystalline (rhombohedric) metal, not readily tarnishing in air, and, although volatile, nothing like so volatile as arsenic.

The metal itself is said not to be poisonous, but all its compounds are. Tartar emetic and the chlorides are, toxicologically, the most important of its salts.

Antimony is largely employed in various branches of industry. The metal used for type consists of one-fourth antimony, one-fourth tin, and the rest lead; the antimony being used from the circumstance that it expands a little on cooling, so giving sharpness to the cast. A certain quantity is also added to pewter, Britannia metal, and the old *Pocula Emetica*. The antimonious oxide ground with linseed-oil is used as a white paint, but is much inferior to lead.

Antimony burns when heated to redness, giving off an oxide ($Sb_2 O_3$). It catches fire when powdered and thrown into chlorine and bromine.

Hydrochloric and sulphuric acids have no action upon it when cold, but they have when heated. It is oxidised by hot nitric acid, antimonic acid ($Sb_2 O_5$) being formed. It is freely soluble in nitro-hydrochloric acid.

The salts of antimony are generally white, and are without taste. They are not usually decomposed by heat. They are mostly either insoluble or of difficult solubility in water, but their solubility is increased when organic substances are present. They are generally soluble in hydrochloric acid, but precipitation occurs if the solution be poured into water.

It should be noted that both the metal and its salts usually contain small but notable traces of arsenic.

Compounds of Antimony.

Antimony and Oxygen.	
Antimonious Oxide	$Sb_2 O_3 = 292$
Antimonic Oxide or Antimony Peroxide	$Sb_2 O_5 = 324$
Antimony and Chlorine.	
Antimonious Sulphide	$Sb_2 S_3 = 340$
Antimonic Sulphide (Gold Sulphur)	$Sb_2 S_5 = 404$
Antimony and Sulphur.	
Antimonious Chloride	$Sb Cl_3 = 228{\cdot}5$
Antimonic Chloride	$Sb Cl_5 = 299{\cdot}5$
Antimony and Hydrogen.	
Antimoniuretted Hydrogen	$Sb H_3 = 125$
Potassio-Tartrate of Antimony	$2 [K (Sb O) C_4 H_4 O_6] H_2 O = 668{\cdot}$

Tartar Emetic or Potassio Tartrate of Antimony.

$2 [K (Sb O) C_4 H_4 O_6] H_2 O.$

(Stibiated Tartar, Tartrate of Antimony and Potash, Tartarised Antimony.)

This is a salt of tartaric acid in combination with potassium and antimony. It is found in commerce either as a white amorphous powder, or in yellowish-white crystalline masses, having a metallic taste and a faintly acid reaction when dissolved. The crystals are octahedral, somewhat efflorescent, and turn orange-red when touched with sulphide of ammonium.

Tartar emetic is soluble in twelve to fourteen parts of water at ordinary temperatures, and in about three parts when boiling. The solution easily decomposes, and even when very dilute, growths of a filamentous nature will be developed in it after standing a short time. It is insoluble in alcohol. If spirit be added to an aqueous solution of even extreme dilution, it precipitates the salt in the form of plumose crystals. When heated in a reduction tube it turns black, the residual mass consisting of the metal and carbon. According to Taylor, the heat of the spirit-lamp is insufficient to effect its sublimation. Mixed with carbonate of sodium, and heated on charcoal with the blowpipe, globules of the metal will be formed, and may be recognised by their extreme brittleness, and by their having a white incrustation around them; but both the metal and the incrustation disappear if the heat be sufficiently intense and long continued.

Lastly, note, as we have said, that tartar emetic often contains a trace of arsenic.

Symptoms, Dose, &c.

In the act of swallowing the poison, the patient complains of an intensely metallic taste. In a short time pain, specially in the region of the stomach and, more or less, over the whole abdomen, comes on. There is usually intense thirst, but drinking is an effort, owing to a feeling of constriction in the throat. Incessant and violent vomiting, with continuous purging, are usually early and likewise hopeful symptoms. If they are absent (as they sometimes are), the case is then more desperate. Intense cardiac depression is a prominent symptom. The pulse may be so feeble that it can scarcely be felt, the skin clammy and cold, the respiration laborious, and the urine, though increased in quantity, passed with pain. Cramps in the extremities, convulsions and spasms of a tetanic nature, often precede death, which results generally from collapse by the depressing action of the poison on the heart. For this reason antimony should not be administered, even medicinally, to old people. The salts of antimony, and especially tartar emetic, are apt to affect the salivary glands. Magendie salivated dogs with tartar emetic, and Dr. Samuel Wright has seen an active ptyalism induced by James's powder. ("Lancet," Sept. 10, 1842, p. 807.) In some cases insensibility has been an early symptom, and, at a later period, a peculiar pustular eruption has been noticed on the skin and throat. Such eruptions are not uncommon even when ointments containing antimony have been applied externally.

The quantity necessary to cause death varies greatly. Recovery is recorded, on several occasions, after half-an-ounce, whilst 1½ grain has proved fatal. Its external application on a plaster, and as an ointment to the spine, has also caused death. The variable results produced by large and small doses may be explained in two ways: (1st) If vomiting and purging are early symptoms, all, or nearly all, the poison may be got rid of. Hence the reason why vomiting and purging render the case hopeful. (2ndly) Peculiar idiosyncrasies. Children can take large doses better than adults. The ordinary effects of antimony, moreover, are not noticed when it is administered in certain diseases, such as in croup and inflammation of the lungs, when even 2 grains may be given at short intervals without bad effects being produced.

In one case death occurred in seven hours. This is the shortest time on record. In other cases it has been delayed for one, two, and four days, and even for two and more weeks.

Treatment.

If vomiting is not present, it must be immediately induced by draughts of warm water, or by hot milk, or by tickling the throat; and if these fail, the stomach-pump should be used without delay.

Tincture of cinchona bark, or any liquids containing tannin, such as strong tea, nut-galls, or decoction of oak-bark, are the proper antidotes.

When the stomach is rid of the poison, strong coffee may be given, and opium to allay the vomiting; whilst blood-letting, as an antiphlogistic, may be indicated. Opiates are often useful in this stage.

Post-Mortem Appearances.

The tongue is usually covered with a white fur. Congestion of the dura mater, effusion between the arachnoid and pia mater, injection of the vessels on the surface of the brain, with congestion of the brain itself, are commonly found. The lungs are frequently of a very deep colour. The stomach and first part of the intestines are generally very inflamed and empty. No case of perforation is recorded, but the stomach in one case appeared as if ulcerated. Both stomach and bowels are generally covered with a thick viscid coating of slimy mucus. The blood is usually black and fluid.

Chronic Antimonial Poisoning: Experiments on Animals.

On more than one occasion death has been caused criminally by the administration of small doses of antimony at intervals, to healthy persons. Nausea and vomiting, with extreme depression, accompanied either by constipation or by a watery purging, death at last resulting from exhaustion, are the prominent symptoms.

Our knowledge of chronic antimonial poisoning is derived from the experiments of several investigators; amongst others, Dr. Nevins ("Liverpool Medico-Chirurgical Journal," No. 1), Orfila, Richardson, and the Messrs. Miller and Lavran ("Ann. d'Hygiène," vol. xxxvi. p. 221). The results of Dr. Nevins's observations we have taken from the abstract in Guy's "Manual." His experiments were conducted on eleven rabbits, to which doses of 0·5 gr., 1·0 gr., and 2·0 grs. were given four times daily. The weakest rabbit died after taking 12, the strongest after taking 72 grains. One died after four, and another after seventeen days. One was killed thirty-one days after it had taken the last dose of the poison, one in fourteen days, and three in one, three, and four days respectively.

The general symptoms noted were emaciation and great loss of appetite. None of them vomited, and in only three cases out of eight was there any diarrhœa; four out of the five had convulsions; and one aborted.

Antimony was found, in every case, in large quantity in the liver, and in smaller quantities in the spleen and stomach. It was found in the kidneys in those animals that survived for some time. It was found in the lungs, and, in those that had lived for fifteen days, in the bones. It was also found in the urine after the animals had taken the twelfth dose; and, lastly, it was found in the fœtal rabbit in the case where abortion occurred.

The appearances after death were in each case great congestion of the liver and inflammation of the mucous membrane of the stomach. In two cases ulceration was observed. The inflammation extended in some cases into the small intestines, the solitary glands being often enlarged and covered with a yellowish deposit, which, on analysis, was found to contain antimony. The colon and rectum were generally healthy, the kidneys somewhat congested, and the lungs very much so. The brain, heart, and spleen were usually normal.

It was long ago proved that large doses of antimony might be given to dogs, and that little effect was produced, provided free vomiting occurred; but that if the gullet was tied, to prevent vomiting, a very few grains would prove fatal. If injected into the veins, a very small quantity induced vomiting and purging, with inflammation of the lungs and alimentary canal. And thus Dr. Nevins concludes that tartar emetic is a deadly poison when repeated in small doses for a sufficient length of time, but that the total quantity necessary to cause death, and the length of time required, vary considerably in different cases: that there is a general similarity in the symptoms and morbid appearances produced, but by no means absolute uniformity: that the poison permeates all the tissues of the body, and even those of the unborn offspring, if its administration be continued long enough, whilst, at the same time, it is constantly being eliminated by the kidneys and bowels: and, lastly, that the fatal effects are often disproportionate to the apparent changes found after death.

As regards the detection of antimony, Orfila records in his "Traité de Toxicologie" the following facts:—

1. That he found antimony in the fat, liver, and bones of a dog that had taken, three months and a half before its death, 46·5 grains of tartar emetic during the course of ten days. No antimony had been taken afterwards.

2. That similar results were obtained in a second case, in which the interval was four months.

3. Tartar emetic was administered to a bitch for a period of five days, fifteen days before she littered. The pups were born at full time. Both the pups and the mother were then killed, and antimony, on analysis, was found in them all.

Dr. Richardson's experiments ("Lancet," May 10, 1856) are important. A dog died in 1 hour and 40 minutes after a dram of tartar emetic in solution had been injected into the cellular tissue. The symptoms did not set in for thirty minutes. After death, both sides of the heart were found to be distended; the lungs dark, and full of blood, but not inflamed; the bladder empty, and the blood generally fluid. The mucous membrane of the stomach was bright pink. The antimony was found in the following parts, beginning with that part where the largest quantity was discovered: blood, vomit, rectum, lungs, liver, stomach, bladder, kidneys, and small intestines.

In a second experiment, made with antimoniuretted hydrogen, a dog was placed in a glass chamber capable of holding 3,000 cubic inches of air; 100 cubic inches of the gas was admitted every twenty minutes, and at the end of 3 hours and 50 minutes the dog died. No symptoms set in for 1 hour and 40 minutes, when purging occurred, and, in ten minutes afterwards, vomiting. Extreme prostration, however, was the prominent symptom.

In the post-mortem all the viscera were found congested; the blood loosely coagulated; the lungs inflated and full of blood, but not specially inflamed.

In a third experiment, a wound in a dog's neck was dressed every morning with tartar emetic ointment. The dog died in seven days. There was no purging or vomiting, but the animal refused food, and died exhausted, as if from inanition.

The blood was fluid, the stomach red internally, and the heart full on both sides. No antimony was found in the brain, but it was found in larger quantities both in the liver and in the spleen than in the other organs.

Tests.

It will be noticed that the following are the tests for antimony, but that only a few are tests for antimony in the form of tartar emetic. In a solution of tartar emetic, after the antimony has been thrown down with sulphuretted hydrogen, and filtered off, the cream of tartar ($K\,H\,C_4\,H_4\,O_6$) may be obtained by evaporating the filtrate to dryness.

1. A drop of the solution of tartar emetic evaporated to dryness, yields tetrahedral crystals of the salt.

2. The solution has a metallic taste and an acid reaction. It is decomposed by keeping.

3. No precipitate is produced with *ferrocyanide of potassium;* and thus it is known from most other metallic poisons.

4. *Sulphuretted hydrogen* gives, with a solution rendered acid by tartaric acid, or by a mere drop of hydrochloric acid, the characteristic orange-red precipitate of antimonious sulphide ($Sb_2\,S_3$), the depth of colour being somewhat dependent on the quantity of antimony present.

This precipitate is to be collected, and well washed.

Note the following properties and reactions of the precipitate ($Sb_2\,S_3$):

(*a*) It is not soluble in ammonia.
(*b*) It is soluble in strong solutions of caustic potash.
(*c*) It is soluble in strong hydrochloric acid, sulphuretted hydrogen being given off, which may be known by its smell and by blackening lead-paper. Chloride of antimony ($Sb\,Cl_3$) will be found in solution.
(*d*) The hydrochloric acid solution of the chloride (*c*) poured into water gives a white precipitate of oxychloride of antimony, which is soluble in tartaric acid.
(*e*) The precipitated sulphide ($Sb_2\,S_3$) is soluble in sulphide of ammonium, but is re-precipitated of an orange-red colour when an acid is added.

5. *Reinsch's Test.* (For general directions in performing the experiment, see "*Arsenic.*")

Make the experiment as follows:—

The antimonial solution is to be boiled with one-fourth its bulk of pure hydrochloric acid, together with a small piece of pure, well-cleaned copper foil. If antimony be present *in large quantity*, the copper will have a *black* deposit of the metal thrown down upon it, but if it exists only *in small quantity*, the deposit will then appear of a *violet-red* colour.

The copper foil is to be removed, washed, dried, and treated as follows :—

(*a*) Heat the copper foil in a reduction tube, when an *amorphous* sublimate will be produced, close to the heated end of the tube. (No sublimate is produced except with the three metals, antimony, arsenic, and mercury; but the sublimate of *antimony* is *amorphous*, of *arsenic octahedral*, and of *mercury globular.*)

(*β*) Or boil the copper foil in a solution of caustic potash, exposing it every now and then to the air in order to oxidise it. In a short time the antimony will be dissolved, and an antimoniate of potash formed. Acidulate this solution with hydrochloric acid, and pass sulphuretted hydrogen through it, when an orange-red precipitate will be produced, which is to be tested as before directed.

(*γ*) Or boil the copper foil in a weak, feebly alkaline solution of permanganate of potash. The antimonial coating will be dissolved, the permanganate losing its colour, and manganic hydrate precipitated. Filter the solution, treat the filtrate with a few drops of hydrochloric acid, and pass sulphuretted hydrogen through it. (Odling.)

6. *Marsh's Test.* (For general directions see "*Arsenic.*")

Antimoniuretted hydrogen ($Sb\ H_3$) is set free by the action of dilute sulphuric acid on zinc in the presence of antimony. For combination to take place the gas must be nascent.

Note—

(*a*) The gas produces a black stain if allowed to play on a piece of paper moistened with nitrate of silver (antimonide of silver).

(*β*) Pass the gas through a solution of nitrate of silver, when a black precipitate of *antimonide of silver* will be thrown down. (In the case of arsenic, a black precipitate is also thrown down, but this precipitate consists merely of *metallic silver.*) Collect the precipitate, wash and boil for some time in a solution of tartaric acid, filter, and treat the filtrate with sulphuretted hydrogen, when an orange-red precipitate ($Sb_2\ S_3$) will be obtained.

(*γ*) The gas ($Sb\ H_3$) burns with a pale bluish-white flame, giving off white fumes of antimonious oxide ($Sb_2\ O_3$).

(*δ*) A piece of white porcelain held in the flame is soon coated with a black deposit of metallic antimony.

Note the following properties and reactions of this metallic deposit :—

(1) The absence of metallic lustre. It is soot like in appearance.
(2) Its difficult volatilisation.
(3) Its insolubility in a solution of chloride of lime.
(4) Its solubility in sulphide of ammonium, which, on evaporation to dryness, leaves a *bright orange* stain, *soluble* in hydrochloric acid, and *insoluble* in ammonia.

(N.B. The *arsenical* deposit is brilliantly metallic, volatilises with a slight heat, is soluble in a solution of chloride of lime, and in sulphide of ammonium; this latter, on evaporation, leaving a yellow stain insoluble in hydrochloric acid, but soluble in ammonia.)

(5) Treat the antimonial stain with nitro-muriatic acid, and evaporate to dryness. The residue does not give a red precipitate with a solution of nitrate of silver as happens with an arsenical stain.

(ε) Heat the tube conveying the antimoniuretted hydrogen with a spirit-lamp, when a ring of metallic antimony will be found *near* and on both sides of the flame by reason of its slight volatility. (See fig. under Arsenic.)

Note respecting this antimonial stain—

(1) The antimonial stain is difficult to sublime, whilst the arsenical stain sublimes with ease.

(2) No white octahedral sublimate can be formed, as with arsenic.

(3) The metallic deposit of antimony dissolves easily in sulphide of ammonium, leaving an orange stain on evaporation.

7. Acidulate the antimonial solution with about one-tenth its bulk of hydrochloric acid; suspend in the cold mixture a piece of tinfoil, when, either immediately or in the course of some time, a black deposit of the metal will be thrown down on the tin. This does not occur with arsenic.

8. Place a few drops of the solution of antimony, acidulated with hydrochloric acid, in a shallow platinum capsule. Touch the platinum, through the liquid, with a piece of zinc, when metallic antimony will be deposited, and adhere to the platinum. Wash the stain, and dissolve it in warm nitric acid. Evaporate this solution to dryness, and touch with sulphide of ammonium; or else pour a little sulphide of ammonium upon the stain, which readily dissolves it, and evaporate to dryness, when an orange-red precipitate ($Sb_2 S_3$) will be formed. (This test is applicable in the examination of organic liquids, for copper, antimony, &c.)

9. *Action of Acids on Solutions of Tartar Emetic.*

Dilute Nitric Acid gives a white precipitate of subnitrate of antimony, which is soluble in a solution of tartaric acid, and in excess of ammonia. The precipitate turns orange-red when treated with sulphide of ammonium.

Hydrochloric Acid gives a white precipitate in concentrated solutions, which is both soluble in excess, and in a solution of tartaric acid. A similar white precipitate is also produced with lead, silver, and mercury salts, but the antimony precipitate may be known by its turning orange-red with sulphide of ammonium.

Sulphuric Acid gives a white precipitate, soluble in excess of the acid, or in a solution of tartaric acid.

10. *Potash, Soda, and Ammonia* give white precipitates in concentrated solutions, soluble in excess of the precipitant.

11. *Mercuric Chloride* gives a white precipitate.

12. *Infusion of Nut-Galls* gives a dirty yellowish-white precipitate.

13. *Acetate of Lead* gives a white amorphous precipitate, soluble in acetic and tartaric acid.

Quantitative Analysis.

Convert the antimonial compound into a chloride by boiling with nitro-muriatic acid. Filter, dilute with water until a slight cloudiness begins to appear. Then pass sulphuretted hydrogen through the solution, boil to expel excess, dry the precipitate, and weigh.

100 grs. of $Sb_2 S_3$ = 85·88 of Antimonius Oxide, $Sb_2 O_3$
= 196·47 of Tartar Emetic
= 71·76 of Metallic Antimony
= 134·41 of Antimonious Chloride, $Sb Cl_3$.

Toxicological Analysis.

The antimony may exist in organic mixtures both in a soluble and insoluble form. Tannic acid renders the poison insoluble, but the antimonial salts are not affected by albuminous liquids.

The stomach and its contents are to be diluted with water acidulated with a few drops of hydrochloric acid, and with some tartaric acid, and set aside for a short time in a warm place. Afterwards strain and filter the liquid. Pass sulphuretted hydrogen through the filtrate, and let it stand for the precipitate to subside. Collect, wash, and dry the precipitated sulphide. The colour of the precipitate, which should be orange red, may be more or less brown from admixture with organic matters.

Note the following reactions of the precipitate :—

1. It is insoluble in ammonia.
2. Add to it a little strong hydrochloric acid, and dissolve by heat. Sulphuretted hydrogen is evolved, and a chloride of antimony is left in solution.
3. Test this acid liquid as follows :—

   (*a*) Pour a little into water, when the white oxychloride will be precipitated.
   (*b*) Test by "*Marsh's Test,*" and by other tests.

In the examination of the Tissues.

1. Cut the tissues up into very small pieces, and boil them in a flask in a mixture of four parts of water and one part of hydrochloric acid for about a quarter of an hour. Filter.

Test the filtrate by Reinsch's process with copper-foil (*see* tests as before).

2. Or they may be treated by the process of Fresenius and Von Babo ; viz., by destroying the organic matter with chlorate of potash and hydrochloric acid (*see* Arsenic).

Always, if possible, examine the urine. This is most important, as the elimination of antimony by the kidneys is rapid.

Dr. Taylor recommends, when the quantity present is very small, to suspend in the weak acid solution a coil of pure zinc foil wound round a piece of platinum foil, when metallic antimony will, if present, be found deposited on the platinum. Care must be taken that the acid is not present in sufficient quantity to dissolve the zinc. The deposit on the platinum may be treated as follows:—

(*a*) Wash and digest in strong nitric acid until the deposit is dissolved, and evaporate to dryness. Dissolve the residue in hydrochloric acid, and treat the solution with sulphuretted hydrogen.
(*b*) Or dissolve the residue in sulphide of ammonium, evaporate to dryness, and so obtain the orange-red precipitate.

Lastly, it must be remembered antimony is often used as a medicine. It is necessary, therefore, that the quantity present should be estimated, and should be above a mere medicinal dose, so as to make certain it was given or taken as a poison.

Chloride of Antimony ($SbCl_3 = 228{\cdot}5$).
(*Butter of Antimony.*)

This is a very corrosive fuming liquid, and is often dark-coloured or of a yellow tint, from its containing chloride of iron. It is sometimes given to horses, to make them look sleek.

The *symptoms* produced by it set in rapidly, and are usually violent. Death has occurred in ten hours after two or three ounces. In this case narcotic symptoms are reported to have occurred.

In the *post-mortem appearances* we are told in the case above referred to that the stomach and intestines appeared as if charred, the mucous membrane being entirely destroyed. All this shows that chloride of antimony is an exceedingly active poison.

The *treatment*, &c., must be the same as for tartar emetic.

Tests.

In the analysis, in addition to what has been already said, specially note—

1. That if the chloride of antimony be added to water, a yellowish-white precipitate of oxychloride of antimony is thrown down.
2. That this white precipitate is soluble in tartaric acid.
3. That if the precipitate be mixed with carbonate of sodium and heated on a piece of charcoal with the blowpipe, metallic antimony will be obtained.
4. That the solution of the white precipitate in tartaric acid is thrown down as an orange-red precipitate when treated with sulphuretted hydrogen.
5. That after the precipitation by the addition of water, the clear liquid, if tested with nitrate of silver, will be found to contain hydrochloric acid.

[Note here that a white precipitate is also produced when the bismuth salt is added to water, but that sulphuretted hydrogen gives a black precipitate with bismuth, whilst it gives an orange-red precipitate with antimony.]

For recovery from organic mixtures and for further tests (*vide* as before).

Cases of Poisoning by Antimony.

(I.) TARTAR EMETIC.

1.

Orfila's "Toxicologie," vol. i., p. 623. Male: æt. 50. 37 grains.

Symptoms.—Vomiting, purging, convulsions.	*Result.*—Death in 4 days.	

2.

Beck's "Medical Jurisprudence." Child. 15 grains.

Symptoms.—Vomiting and purging; convulsions.	*Result.*—Death in a few weeks.	

3.

"Medical Gazette," vol. 45, p. 801 (Dr. Pollock). Male: æt. 30. ʒj.

Symptoms.—Early and violent vomiting; no convulsions.	*Result.*—Death in 10 hours.	

4.

"Lancet," May 22, 1847, p. 535 (Mr. Freer.) Male: æt. 28. ʒij.

Symptoms.—In one hour spasmodic contraction of muscles; vomited once; watery purging. (Emetics given.)	*Result.*—Recovery.	

5.

"American Journal of Medical Science," Jan. 7, 1853, p. 131. Adult. ℥ss taken by mistake for sulphate of soda.

Symptoms.—Vomiting in half-an-hour. (Green tea and tannin administered.)	*Result.*—Recovery after several days.	

6.

Dr. Taylor's "Medical Jurisprudence," p. 309, vol. i. Male: adult. 200 grs.

Symptoms.—Vomiting in 15 minutes; severe cramps in 3 hours; suppression of urine.	*Result.*—Recovery.	

7.

Taylor's "Medical Jurisprudence," p. 309 (Dr. Proctor). Four children. ℥j of sulphur, and ʒj of tartar emetic between the four.

Symptoms.—Early vomiting and cramps; no difficulty in swallowing, or constriction of throat.	*Result.*—Recovery.	

8.

"Lancet," Jan. 21, 1854 (Dr. Beale). Female: æt. 16. 40—60 grains.

Symptoms.—Vomiting and purging in 15 minutes: a period occurred after a few hours when she seemed better, but a relapse followed. Delirium; dilated pupils.	*Result.*—Death in 36 hours.	*Post-mortem.*—Lungs slightly congested; no inflammation in stomach or intestines.

9.

"Western Journal of Medicine and Surgery" (America), 1848, p. 23 (Dr. Gleaves). Male: adult. ℥ss.

Symptoms.—No vomiting for 1½ hours, when the vomit merely consisted of the matters taken to induce vomiting; purging in two hours.	*Result.*—Recovery in 2 weeks.	

10.
"Boston Medical and Surgical Journal," Dec., 1856, p. 400. Female: æt. 21. Dose?

Symptoms.—Vomiting and purging; no convulsions.	*Result.*—Death in 7 hours.	

11.
"Medical Times and Gazette," March 28, 1857. Female. Gr. iss. ō gr. xv of ipecacuanha given five days after confinement.

Symptoms.—Vomiting, purging.	*Result.*—Death.	

12.
"Lancet," May 19, 1838, p. 220 (Orfila). Male: adult. ℈j.

Symptoms.—Pain, vomiting, and diarrhœa; distressing cramps.	*Result.*—Recovery.	

13.
"Lancet," May 19, 1838, p. 250 (M. Recamier). Male: adult. 40 grains.

Symptoms.—Vomiting; purging; convulsions.		

14.
"Lancet," May 19, 1838, p. 250. Female: æt. 20. A plaster sprinkled with ʒss of tartar emetic applied to the epigastrium after the application of leeches.

Symptoms.—Aphthæ in mouth.	*Result.*—Death.	

15.
"Lancet," May 19, 1838, p. 250. Æt. 2. Spine rubbed with tartar emetic ointment.

Symptoms.—Sickness.	*Result.*—Death in 48 hours.	

16.
"Lancet," April 12, 1856, p. 400 (Dr. B. W. Richardson). Male. About 3 grains was dropped into the medicine bottle and not well mixed; taken at a dose.

Symptoms.—Symptoms very severe, and nearly fatal. The man suffered from acute inflammatory symptoms.	*Result.*—Recovery.	

17.
"Lancet," April 12, 1856, p. 400 (Dr. B. W. Richardson). Male: adult. 15♏ of antimony wine.

Symptoms.—Nausea incessant; prostration great; no purging.	*Result*—Recovery.	

18.
"Medical Times and Gazette," Oct. 6, 1866, p. 379 (Dr. Gabb). Male: æt. 43. Three teaspoonfuls of tartar emetic = ʒij at least. He took some vinegar shortly after.

Symptoms.—No vomiting for more than an hour, when sickness and purging came on. In four hours violent cramps in the legs were complained of, but no pain at the stomach. He got better for a time, but had a relapse and died.	*Result.*—Death in 40 hours.	

19.
"Lancet," April 25, 1840, p. 460 (Mr. Hartley). Male: æt. 5. Female: æt. 3. Each had a powder containing 10 grains of tartar emetic.

Symptoms.—In 20 minutes both children had vomiting and purging, with tetanic spasms. The boy died in 8 hours, the girl in 12 or 13 hours.	*Result.*—Deaths in 8 and in 12 hours.	*Post-mortem* on girl.—Lungs somewhat congested; liver healthy; peritoneal coat of intestines inflamed; duodenum inflamed; mucous membrane of stomach much inflamed; brain very congested. *Post-mortem* on boy.—Similar. Spots on stomach, as if ulcerated; and a scarlatinal eruption on the arms, legs, and neck.

(II.) CHLORIDE OF ANTIMONY.

20.

Taylor's "Medical Jurisprudence," p. 315. Male: æt. 12. ʒiv – ʒv taken in mistake for ginger beer.

Symptoms.—Vomiting in 2 hours.	*Result.* – Recovery.	

21.

Taylor's "Medical Jurisprudence," p. 315 (Mr. Mann). Male: adult. ℥ij—℥iij.

Symptoms.—Great pain; incessant attempts to vomit and to evacuate the bowels. After some hours there was a great desire to sleep.	*Result.*—Death in 10½ hours.	*Post-mortem.*—The whole alimentary tract appeared black, as if charred. The mucous membrane was entirely destroyed.

22.

Taylor's "Medical Jurisprudence," p. 316 (Mr. Evans). Male: adult. ℥iij of bronzing liquid = solution of Sb_2 Cl.

Symptoms.—Pain; vomiting; no purging.	*Result.*—Death in 18 hours.	*Post-mortem.* — Intense inflammatory action in stomach; no perforation; putty-like masses, which contained antimony, found in stomach.

23.

"Lancet," Dec. 4, 1841, p. 324 (Mr. Houghton). Male: æt. 10. A tablespoonful.

Symptoms.—Immediate choking and burning pain. Recovered in 2 days.	*Result.*—Recovery.	

24.

"Lancet," Feb. 26, 1848, p. 230 (Mr. Weeden Cooke). Male: æt. 41. ℥j of chloride of antimony.

Symptoms.—Immediate burning sensation; insensibility; pulse very small; apparently complete collapse. Recovered in a few days.	*Result.*—Recovery.	

25.

"Medical Times and Gazette," Oct. 22, 1864, p. 448 (Dr. Crisp). Female: æt. 19. ℥iij.

Symptoms.—Great pain; thirst; vomiting; diarrhœa; no urine passed; the mind remained clear; lips and mouth black and excoriated.	*Result.*—Death in 24 hours.	*Post-mortem.*—Stomach appeared uniformly covered with antimony. When this was removed, the mucous membrane appeared black and charred. Part of the small intestines also affected.

See the following Cases of Antimonial Poisoning:—

"Medical Times and Gazette," vol. ii., 1860, pp. 12, 190, 213, and 271. (Suspected deaths at Yeovil and Liverpool.)

"Medical Times," March 22, 1841, p. 306. (Tartar emetic.)

"Medical Times," Jan. 17 and Feb. 7, 1846, pp. 322 and 381. Death of boy and girl.

"Medical Times," June 24, 1848, p. 127 (a tablespoonful of tartar emetic). Recovery; symptoms severe; pustular eruption.

"Medical Times," March 16, 1844. (10 grs. Dover's powder.) Death in 20 hours of a child seven weeks old.

"Medical Times and Gazette," April 4, 1868, p. 384. Death from a dose of antimony, taken in a seidlitz powder by a drunken woman to produce "quietness."

"Medical Gazette," vol. 44, p. 334.

"Association Medical Journal," June 10, 1853, p. 513.

"Guy's Hospital Reports," October, 1857 (Dr. Taylor).

"Lancet," Aug. 30, 1856, p. 259 (Regina *v.* McMullen). Antimony given as a cure for drunkenness.

"Medical Times and Gazette," August 25, and September 15 and 29, 1860.

"American Journal of Medical Science," Jan. 1853, p. 131.

ARSENICUM.

(Symb. As. At. wt. 75; sp. gr.: solid, 5·97; vapour, 10·6; volatilises at 180° C. (356° F.).)

It is prepared either

(1) By subliming the metal from some ore which contains it in an uncombined state; or

(2) By subliming the arsenical sulphide of iron (Fe As S) (Mispickel), obtained chiefly from Silesian mines, the arsenicum being given off as white arsenic ($As_2 O_3$).

Arsenicum is a brittle, steel-grey metal, has a brilliantly metallic lustre, and is far more volatile than antimony. The vapour has a peculiar garlic-like odour. The metal is a conductor of electricity. In making small shot it is mixed with lead in order to facilitate its assuming a globular form. When powdered and thrown into chlorine it catches fire. It easily combines with bromine, iodine, and sulphur when heated with them. It is readily oxidized either by hot sulphuric or nitric acids, hydrochloric acid having but little or no action upon it. It is soluble in a solution of bleaching powder. Heated in air it is converted into arsenious anhydride ($As_2 O_3$).

Metallic arsenic acts as a powerful* poison, although it is doubtful whether it does so until it becomes converted into arsenious acid. It is, however, a question of no great practical importance, as the process of oxidation in the body is rapid.

Compounds with Oxygen.

1. Arsenious Anhydride (white arsenic; arsenious acid) $As^2 O^3$
(Salts are called Arsenites).
2. Arsenic Anhydride . . . . $As^2 O^5$
(Salts are called Arsenates).

Compounds with Sulphur.

1. Sulphide of Arsenic.	Realgar.	Colour, *ruby red* .	$As^2 S^2$
2. do.	Orpiment.	Colour, *bright yellow*	$As^2 S^3$
3. do.		Colour, *do.* .	$As^2 S^5$

Compound with Chlorine.

1. Chloride of Arsenicum . . . . $As\ Cl_3$

Compound with Iodine.

1. Iodide of Arsenicum . . . . $As\ I_3$

Compound with Hydrogen.

1. Arseniuretted Hydrogen . . . . $As\ H_3$

It also enters into other combinations.

We shall now examine arsenious acid in detail, and as we proceed, the reactions, &c., of the other compounds of arsenicum will suggest themselves. Arsenious acid has been known for a long time as an active drug, and constituted the poisonous ingredient of the "Aqua Toffana" of the sixteenth century.

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* "Fly powder" consists of a mixture of arsenious acid and metallic arsenic.

The cases of poisoning by arsenic have much diminished of late, owing to the Act of 1851 (14 Vict. cap. xiii. sec. 3), which not only restricts its sale, but requires that when sold retail and in small quantity, it should be mixed with soot or indigo.

Arsenious Anhydride ($As_2O_3 = 198$).

(Arsenic; White Arsenic; Arsenious Acid; Rats-bane.)

(Sp. gr. of opaque form 3·65, of the transparent 3·75; sp. gr. of vapour 13·8; sublimes at 137·6 C.)

It is prepared either

(1) During the roasting of arsenical ores in a current of air; or
(2) By heating metallic arsenic in the presence of air.

Its uses are numerous. It was formerly put into candles to harden them, and to give them a wax-like appearance. (Corpse candles). Extremely dangerous effects were produced by the slow volatilization of the arsenic whilst the candles were burning. We may remark here that the arsenic may easily be detected in candles by boiling the fatty matter in water, and removing the fat *en masse* when the water is cold. The arsenic will then be found in solution. The arsenite of copper is occasionally used for colouring green tapers, although, as a rule, verdigris is employed for this purpose. The authors have found the arsenite in these tapers on several occasions, in one case as much as was equal to 1 per cent. of arsenious acid being present.

Wheat is often steeped in an arsenical solution, and this has been a cause of accidental poisoning, both to men and animals ("Lancet," March 9, 1850, p. 312). An arsenical solution is also used by shepherds as a sheepwash. Bad effects have been produced on those engaged in washing the sheep with it ("Lancet," Sept. 12, 1857, p. 281), whilst on more than one occasion accidents have resulted from wine being put into a bottle that had been used for the wash without its having been previously cleansed ("Lancet," Oct. 18, 1856, p. 447).

Arsenic is also used in glass-making and in white enamelling. It is used by grooms for horses from some fancied belief that it renders their coats sleek. It forms a constituent of many of the vermin killers and rat pastes. Its use as a rat paste has more than once proved serious in places supplied with water by wells. The poisoned rat, tormented by thirst, rushes to the well to allay it, and is drowned or dies there, and at the same time contaminates the water with the poison. "Simpson's Rat Paste" is a compound of starch, smalt, and arsenious acid (40 per cent.), scented with oil of rhodium (Herapath). (*Vide* fatal case, "British Medical Journal," May 6, 1865, p. 473.)

Arsenic is also used in stuffing animals, and in preparing specimens on account of its preservative power. A case is recorded of well-marked arsenical symptoms being produced by merely keeping birds that had been stuffed with an arsenical preparation in a room. ("Lancet," April 23, 1853, p. 397.)

Some quack pills also contain it (Reg. *v.* Bone, Hertford Assizes, 1874).

Physical Properties.

It exists in two forms. (1) A *vitreous form*, which is transparent and colourless when first made, but becomes yellowish, white, opaque, and somewhat like porcelain after exposure to air. Some doubt exists as to the true cause of this change. (2) A *crystalline form* (octahedra), which arsenic assumes when it is carefully sublimed in small quantities, or crystallized out from a hydrochloric acid solution.

It is very nearly, if not entirely, destitute of both taste and smell. The opaque variety has a lower specific gravity than the transparent. Heat converts the opaque form into the vitreous, whilst mere grinding in a mortar converts the vitreous into the opaque. Heated to 137·6° C., it softens and sublimes without fusing, forming transparent octahedral crystals on surfaces that have been warmed. A somewhat characteristic behaviour of arsenic is the white layer that it forms on the surface of water when thrown into it in a state of powder.

Chemical Properties.

Arsenious acid has feebly acid properties, but it readily combines with bases, the salts being called *arsenites*. They are generally easily decomposed by a stronger acid. All arsenites of the alkalies are soluble in water, and are very poisonous. All the other arsenites are almost insoluble, and hence the action of lime and magnesia when used as antidotes. Most of the arsenites are decomposed by heat, whilst all when heated with a reducing agent evolve the metal in a vaporous form.

Arsenious acid is readily soluble in solutions of the fixed caustic alkalies, but is not so soluble in ammonia. It is very slightly soluble in sulphuric acid, but is freely soluble in hot nitric acid, when the arsenious is changed to arsenic acid. It is also readily soluble in hydrochloric and in some vegetable acids, in alcohol (1 in 2000 of alcohol, sp. gr. 0·802), and in chloroform (1 in 200,000), but is insoluble in absolute ether. When chlorine is passed through a solution of the acid, arsenic acid is formed.

The solubility of arsenic in water is a question of very considerable medico-legal importance. There are great variations in the results obtained by different investigators. The following are the chief circumstances that serve to modify the dissolving action of water on the acid:—

1. The peculiar modification of acid used.
2. Its admixture or contamination with organic matter. It is said that the presence of greasy matter, such as bacon, reduces the solubility of arsenious acid to $\frac{1}{20}$th. If this be the fact, it affords a partial explanation of why sometimes its action seems to be suspended.—(Dr. Blondlot, "Medical Times and Gazette," Feb. 11, 1860.)
3. The length of time the water has acted.
4. The temperature of the water.
5. If boiled, the length of time that the boiling was continued.
6. The time that has elapsed between boiling and the examination.

We will endeavour to state a few results we have obtained in a tabular form, so as to show them as clearly as possible.

Solubility of Arsenious Acid.

	Transparent form.	Opaque form.	Fresh crystalline acid.
1000 grains of cold distilled water after standing for 24 hours, dissolved ...	1·74 grains.	1·16 grains.	2·0 grains.
1000 grains of boiling water poured on the acid, and allowed to stand for 24 hours, dissolved.	10·12 „	5·4 „	15·0 „
1000 grains of water boiled for one hour, the quantity being kept uniform by the addition of boiling water from time to time, and filtered immediately, dissolved	64·5 „	76·5 „	87·0 „

Symptoms; Dose, &c.

How soon after the poison is taken do the symptoms of arsenical poisoning commence? This is an important medico-legal question. Cases are recorded where the symptoms have set in immediately. In one-half of the recorded cases they have commenced within two hours, and in two-thirds within five hours. In two cases that are on record, no active symptoms occurred before the fourth day. It will, however, generally be found that in cases where the symptoms are delayed for some hours, either that the person went to sleep after taking the poison (for during sleep the animal system is peculiarly inactive), or that the poison was taken with or soon after a meal. Of course, too, the form in which it was swallowed, that is, whether solid or in solution, largely influences the rapidity of its action.

The symptoms are those of an intense irritant. The countenance tells of severe suffering. There is generally great depression, followed by a "fire burning" pain in the pit of the stomach, aggravated by the slightest pressure. Diarrhœa with tenesmus, burning pains at the anus, and intensely painful cramps in the legs are usual. We invariably find violent vomiting, increased by taking the least thing into the stomach, the vomit consisting either of a white gummy matter from admixture with the poison, or of a brown liquid mixed with bile, and sometimes blood. During the vomiting the patient complains of the great heat and constriction felt in the throat. There is usually dysuria, the quantity of urine passed being, as a rule, diminished in quantity, but not suppressed. Some have asserted there is no retention, but simply a constant desire to micturate, whilst others hold that retention is a marked symptom of arsenical poisoning ("Medical Times and Gazette," March 24, 1866, p. 328).

The thirst is intense, the skin dry and hot, the headache severe, the pulse small and rapid, the tongue dry and furred, the breathing catching, the eyes suffused and smarting, the conjunctivæ being red, with great intolerance of light, great general restlessness, twitchings in the extremities, but generally a perfectly clear mind. The nervous symptoms are intense and long continued. These symptoms may terminate in several ways.

(*a*) *Convulsions*, with fits of an epileptic nature. Tetanic spasms, and in one case lock-jaw, are recorded as early symptoms.

(*b*) The case may assume merely the form of English cholera, and the practitioner be in this way thrown off his guard.

(*See* Dr. Letheby on points of similarity and dissimilarity between cholera and arsenical poisoning, "Medical Times," Nov. 11, 1848, p. 76; also Virchow's "Archiv." xlvii. 524.)

(*c*) *Collapse,* with or without (as happens in some very exceptional cases), pain, vomiting, or diarrhœa. In these cases death is usually very rapid, but the mind is clear to the end.

(*d*) *Intense coma,* as in the case related by Mr. Wright, of Dublin.

(*e*) Death may be almost immediate, as if by shock.

But the symptoms of arsenical poisoning, it must be admitted, are often anomalous and perplexing, nor is it possible always to explain them. Often there is an irritation and *eruption of the skin* of a severe character (Christison, p. 328; Dr. Schlender's case of arseniuretted hydrogen poisoning); sometimes, and not uncommonly, *local paralysis* ("Lancet," June 7, 1845; "Lancet," July 6, 1844; "American Journal of Medical Science," July, 1851); sometimes *salivation,* and even *mania* are recorded as having occurred (Christison, p. 316). Sometimes the symptoms suddenly disappear for some hours, to come on with renewed vigour ("London Medical Chirurgical Transactions," II., 134; "Chemical News," Dec. 26, 1863). Sometimes the patient dies without literally any bad or severe symptoms at all ("Provincial Journal," June 28, 1848; Christison, p. 310). In all forms, however, arsenic is a poison. The gaseous form is, as we should expect, the most active, and of the rest it may be said that the greater the solubility the more intense are their poisonous properties. It is a poison, too, however administered, whether applied to the sound skin ("Mem. of London Medical Society," II., 397, Mr. Sherwen's experiments), or used as a wash ("American Journal of Medical Science," July, 1851), or applied to the scalp ("British Medical Journal," March 5, 1864, p. 276), or applied as an ointment to a tumour ("British Medical Journal," Oct. 6, 1866, p. 395), or used as a plaster ("Lancet," March 20, 1869, p. 410, and Oct. 3, 1868, p. 457), or applied to the nostrils (Christison, p. 328), or applied to wounds or ulcers (Christison, p. 320-321), or applied to the rectum or vagina (Christison, p. 323), or administered internally as solid, liquid, or gas.

The *time of death* varies greatly. In one-half of the cases on record it proved fatal within nine hours. But it has killed as soon as twenty minutes, whilst the fatal period has been delayed to ten and sixteen days, and in one case even to two years.

As regards *fatal quantity,* Orfila asserts ("Lancet," Nov. 14, 1840, p. 262), that however much arsenic may be taken into the stomach, the whole quantity absorbed in case of death never exceeds 1·5 to 2 grains. In Dr. Sigmond's lectures in the "Lancet" of Dec. 16th, 1837, the case of a man, æt. 63, is referred to, who took one grain of arsenic in divided doses, and died, it was believed, as the result. A second case is recorded by Roux of a girl, æt. 18, who died after the application of a very weak "pâte arsenicale" to a cancerous breast; and a third case is recorded by Sir Astley Cooper, where death resulted from the application of arsenic to a fungus in the eye, the stomach after death showing all the appearances of arsenical poisoning. In a case recorded by Dr. Letheby, 2·5 grains proved fatal to a girl of nineteen. On the other hand, there are numerous cases on record of recovery after enormous doses. In nearly all these cases, however, two conditions are recorded; first, that the poison was taken after a full meal, and secondly, that very early and free vomiting occurred. This indeed is doubtless the explanation of many cases which otherwise appear unexplainable. Nor must we forget to mention the remarkable stories of the arsenic eaters of Styria and Lower Austria; stories, indeed, which it is as hard to credit as it is impossible to explain ("Lancet," January 17, 1852, p. 85). We have also a curious case on record of an English arsenic eater, who was able to take very large quantities of the poison ("Medical Times and Gazette," Oct. 6, 1866, p. 375). Arsenic is also said to be used largely by the Cingalese. Its method of preparation by them is curious ("Medical Times and Gazette," Oct. 25, 1862, p. 454). It has been stated that the intensity of arsenic as a poison is increased by its admixture with certain salts, such as nitre ("Medical Times," Dec. 7, 1844, p. 216).

(Respecting the tolerance for arsenic, see Headland on the "Action of Medicines," p. 400.)

Further, it has been stated that the poisonous effects of arsenic are greatly aggravated when it is administered after antimony has been given and during the intermission of its use. Under such circumstances even medicinal doses have proved dangerous ("Medical Times and Gazette," May 22, 1858, p. 524).

Treatment.

Never neglect treatment because the case looks hopeless. As a rule vomiting sets in spontaneously; and if the poison has been taken on a *full stomach* the whole of it may in this way be got rid of. Not so, however, if taken on an *empty one*, for then the arsenic sticks to the stomach, sets up intense inflammation, and becomes glued to the coats by the exudation of coagulable lymph (Ann. d'Hyg. xxx. pp. 124-423).

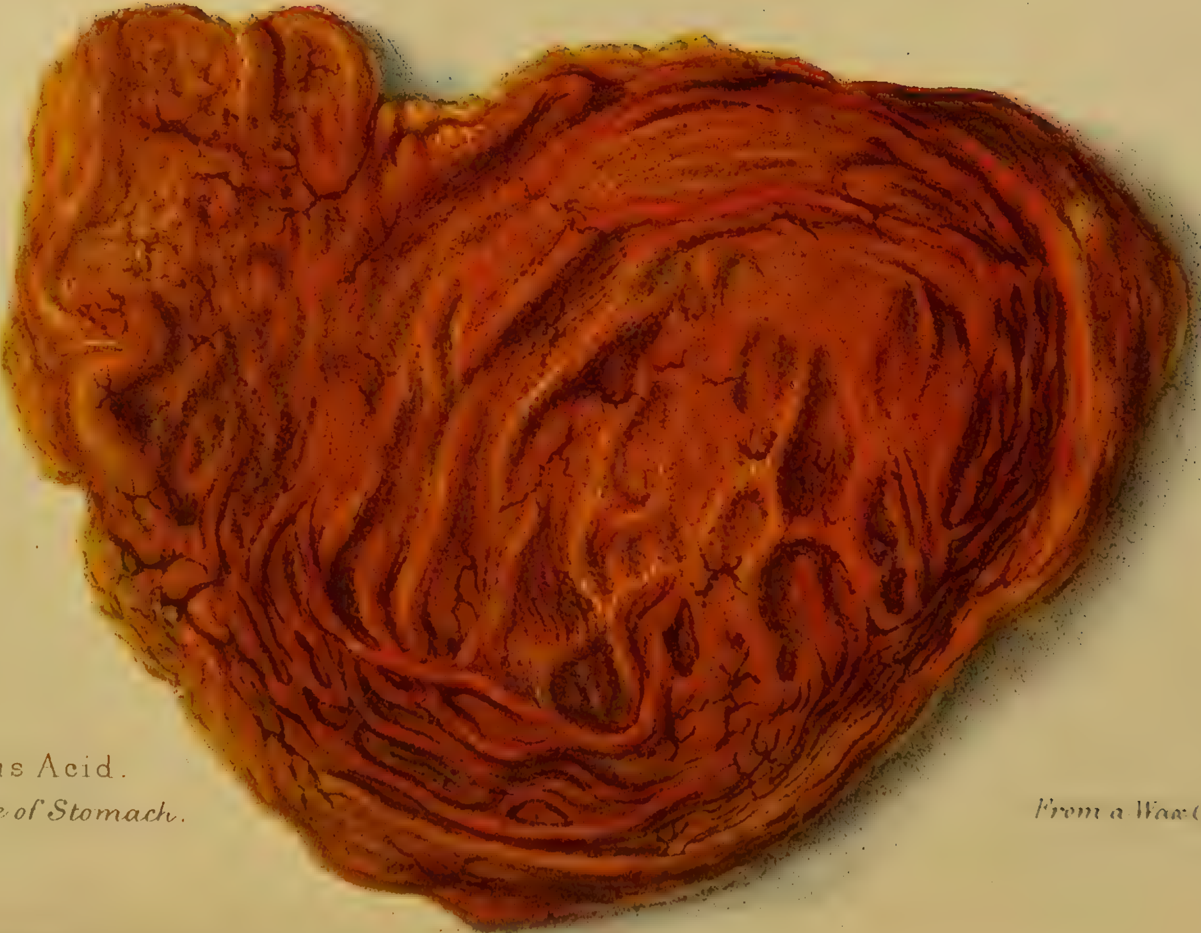
If the case is seen *immediately* after the poison has been taken, the stomach-pump may be used, but not under any circumstances afterwards. To get rid of the poison, which must be your first endeavour, administer hot milk and water, and emetics of sulphate of zinc or mustard, at the same time tickle the throat with a feather. But do not give antimony.

After free vomiting give milk and eggs. Sugar and magnesia in milk is a good mixture, an insoluble compound with arsenious acid being in this way formed. Treat symptoms as they arise: collapse with stimulants, nervous symptoms with anodynes, coma by venesection, tetanus with chloroform, thirst with water.

The hydrated peroxides of iron and magnesia are much lauded by some as antidotes in cases of arsenical poisoning. The first is prepared by precipitating the muriatic tincture of iron with excess of ammonia, collecting the precipitate on a filter paper, and well washing it with water, and the second by precipitating a strong solution of sulphate of magnesia with liquor potassæ. Each must be prepared fresh and given whilst moist. They should, to be of any good, be administered at least in the proportion of 20 parts of the iron compound to every 1 of the acid taken (See experiments by Dr. Donald Mackenzie, "Lancet," April 4, 1840, p. 46).

The permanganate of potash, well diluted, is also recommended, in order to convert arsenious into arsenic acid.

Plate I.



Arsenious Acid.

P. M. Appearance of Stomach.

From a Wax Cast by Dr. Letheby.

F. Burgess del. et ch. lith.

H. Wax & Co. imp.

The hydrated sulphide of iron (recommended by Mialhe), acetate of iron, animal and vegetable charcoal, and albumen, are all next to useless.

Lastly, act on the kidneys by frequently repeated doses of nitrate of potash. For the kidneys, it is to be remembered, are the great excretors of the poison.

Post-Mortem Appearances.

We may remark first, that several cases are recorded where no special after-death appearances were discovered. In one such case the patient lived for twelve hours and the vomiting had been violent (Professor Wagner: Horn's Archiv., 1834: 755). As a rule, where all absence of abnormal change is noted, death has been unusually rapid; but, on the contrary, it must not be forgotten that death may be very rapid, and yet well-marked post-mortem appearances be found.

The post-mortem appearances usually discovered are those common to the action of irritant poisons. Their intensity for the most part depend on two circumstances: (1), the amount taken, and (2), the length of time the patient lived after taking it. The stomach is acutely inflamed, either in its entirety or in patches, the inflamed parts being often covered with coagulable lymph mixed with solid arsenic, supposing the poison to have been taken in that form. One well-marked peculiarity must specially be noted, and that is, that the stomach is generally studded with minute petechious dots (see plate I.). This condition is often apparent, even when death has taken place after two or three hours. The coats of the stomach are sometimes thickened and corrugated (and this is the common appearance), whilst at other times they appear thinner than normal. Ulceration is rare, but it has been found even when death has occurred as early as ten hours after the poison has been swallowed. Perforation and gangrene are still more uncommon (for arsenic is not a *corrosive* poison), although such cases are on record. The intestines may be inflamed along their whole length, but more often the inflammation is limited to the duodenum. The colon is often very contracted, and the rectum is invariably the seat of acute inflammation. Congestion of the œsophagus, mouth, and windpipe, from the application of the poison during vomiting is general. Inflammation of the bladder and peritoneum, enlargement of the intestinal glands, livid spots on the skin, congestion and serous effusion of the brain, are occasionally found. It is remarkable that, as a rule, no special post-mortem appearances will be noticed in the liver, spleen, or kidneys, although these are the great receptacles of the poison. The blood is usually fluid. Dr. Wilks has pointed out that ecchymosis of the heart is common ("Medical Times and Gazette," June 18, 1862, p. 70). Sometimes the organs of generation are greatly inflamed.

It is stated that after death by arsenical poisoning, the body has a peculiar alliaceous odour. The authors have never been able to detect it.

Further, we must note the great preservative power of arsenic. It is on account of this property that we employ it for injecting bodies in the dissecting room, and for the same reason it is used in stuffing birds and animals. Dr. Wormley tells of a case where a body was found to be well preserved seventeen months after poisoning by arsenic, whilst others record cases of bodies remaining in good condition for very much longer periods. But some cases are on record (exceptional cases, it must be admitted) of the reverse. How far this may be due to the arsenic having been entirely removed from the body by vomiting is the question, and may be the true explanation.

Chronic Arsenical Poisoning.

Chronic arsenical poisoning has been carefully investigated by Dr. George Harley ("Lancet," Nov. 23, 1861, p. 499). The following are some of the results at which he arrives:—

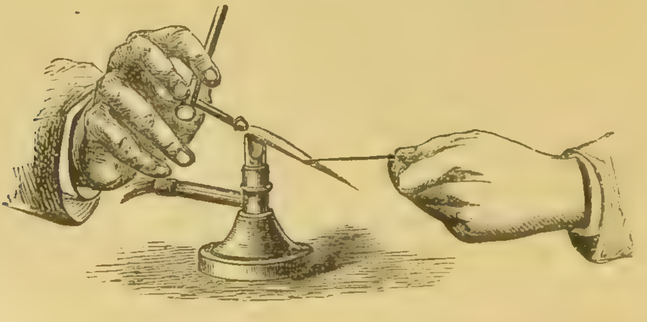
1. That arsenic has a specific action on the digestive canal.
2. That the action of arsenic on the digestive canal is manifested irrespectively of its mode of administration.
3. That the effects of the direct contact of arsenic with the mucous membrane is slight compared with the influence it exerts through the blood.
4. That the symptoms and post-mortem appearances of acute and chronic poisoning differ materially.
5. That the post-mortem changes in the *acute* form are most marked at the cardiac, and in the *chronic* form at the pyloric end of the stomach.
6. That the more gradual the poisoning the more manifest is the action of the poison on the intestines, and the less manifest its action on the stomach.
7. That death may occur so rapidly that no structural change will be discoverable.
8. That the immunity of arsenic eaters is probably due to their taking it in a solid form, and consequently a very small portion only entering the circulation.
9. That the beneficial effects of arsenic as a medicine are due to its diminishing tissue change by its peculiar action on the blood.
10. That its prejudicial effects are due to its destroying the power of the blood to become oxidized, and of thereby being fitted for the purposes of nutrition.

Tests.

I. *For Solid Arsenious Acid.*

1. Heat a small quantity of the acid on platinum foil, when it will be found to volatilize completely, opaque white garlic-scented fumes being given off. If any residue be left it is impurity, and probably sulphate of lime.

FIG. 10.



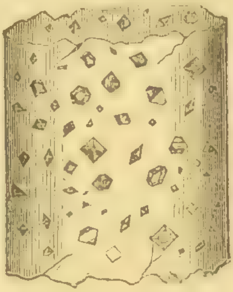
The evolution of the white fumes is well marked when the acid is thrown on a hot coal.

2. Heat a small portion of the acid on a clean platinum wire in a

blowpipe flame. The flame will be found to be tinged of a pale blue colour (arsenical flame), white fumes being given off. (Fig. 10.)

3. Put a small quantity of the acid into a reduction tube, and warm the portion of the tube just above the acid previously to heating the acid itself. After this, apply the flame to the acid, when a sublimate which sparkles when the tube is held against a black background, will be formed on that part of the tube that has been heated, but it is to be noted that the arsenious acid itself *has not melted.* The crystals on being examined with a strong lens, will be found to be *octahedral*, having triangular facets, rarely of any other form, and invariably separate and distinct (figs. 11 and 12). If the portion of the tube where the sublimate collects is not warmed, the sublimate will not be crystalline but amorphous.

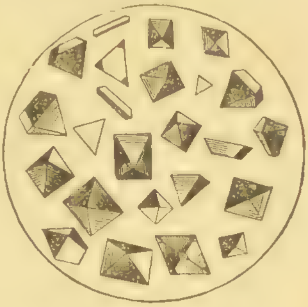
FIG. 11.



(Note that oxalic acid, corrosive sublimate, and ammonia salts, yield crystalline sublimates, but that none of these sublime before melting, and none produce octahedral crystals).

That part of the tube containing the sublimate of arsenious acid should now be broken off and boiled in water for some time, and the solution examined for the acid by the liquid tests. If there is only a small quantity for analysis it is not advisable to use a larger reduction tube than $\frac{1}{12}$th in. diameter, and to draw it out, so that you may sublime the arsenious acid ($As_2 O_3$) into the capillary portion, which can then be easily examined under the microscope for the crystals. It has been suggested to collect the sublimate on a flat glass, but for practical purposes the method we have described is much to be preferred.

FIG. 12.



4. Boil some of the powder of arsenious acid in a beaker in water; little lumps of the acid will be found at the bottom of the beaker, and a white film will collect upon the surface of the water, which will be equally apparent whether the water be cold or hot.

5. Add to a small quantity of the acid placed in a watch glass, a little sulphide of ammonium. No change of colour will result. If a gradual heat be now applied the arsenic will dissolve, and as soon as all the ammonia is dissipated, a yellow film of sulphide of arsenicum will be left, which is soluble in alkalies, but insoluble in hydrochloric acid.

6. Take a *dry* warm narrow hard glass reduction tube (avoiding German glass, because it contains lead), about four inches long and $\frac{1}{8}$th in. diameter, and place in it a small quantity of arsenious acid well mixed with some reducing agent, taking care not to soil the tube in introducing the mixture. (Dr. Letheby recommends as a reducing agent a mixture of powdered charcoal and carbonate of sodium, and Dr. Taylor, one part of cyanide of potassium and three parts of dry carbonate of sodium. Acetate of sodium well incinerated, mixed either with finely powdered and recently ignited charcoal or dried ferro-cyanide of potassium

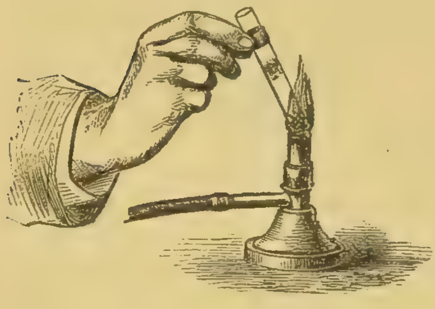
is recommended by others as a flux.) Cover the tube, holding it obliquely, loosely with the finger, and apply the heat of a spirit lamp or of a gas flame to the mixture (fig. 13).

Note as follows :—

A. *The garlic odour*, which is especially produced as the metal passes from the metallic state to that of arsenious acid. This garlic odour is not, however, peculiar to arsenic.

B. *The dark brown or black ring of metallic arsenic*, formed about half an inch above the mixture in the cool part of the tube (fig. 14) (*b*). This ring is often double, the lower part being brilliantly metallic, but the upper part less lustrous, and merging off at its upper margin into an arsenious acid sublimate. The internal part of the ring will usually be seen to be distinctly crystalline.

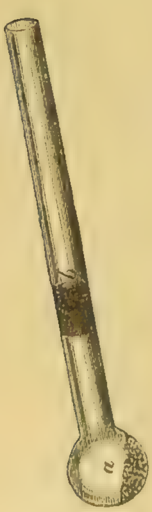
FIG. 13.



C. The ring of metallic arsenic will be found to be very volatile, and when heat is applied to it, it can be made to pass up and down the tube, the sublimate collecting on those parts that are cold; and

D. It will be found that after repeated volatilizations in the presence of plenty of air, the whole of the metal will become oxidized, and white octahedral crystals of arsenious acid only be left. This is undoubted evidence of its arsenical nature. It will be advisable, in order to obtain the complete oxidation of the arsenicum, if in any quantity, to cut away the part of the tube containing the metallic ring, to put it into a test tube where the supply of air is abundant, and then to apply heat.

FIG. 14.



E. The sublimate of arsenious acid thus obtained is to be boiled with water, and the solution examined by the liquid tests.

F. Or, instead of oxidizing the metallic sublimate as above, dissolve the ring of metallic arsenic in a drop or two of dilute nitro-muriatic acid, and evaporate the solution to dryness, when arsenic acid will be left. This is to be dissolved in a little water, and treated with a solution of nitrate of silver, when a red-brick precipitate of arsenate of silver will be produced.

G. The metallic sublimate is soluble in a solution of hypochlorite of soda or lime.

Fallacies: Mercury compounds, cadmium, tellurium, and selenium, like arsenicum, yield sublimates, but as a rule they appear globular even to the naked eye. The globules of a selenium sublimate are of a port-wine colour. Tellurium occasionally produces a crystalline sublimate (telluric acid), But

(1) None yield octahedral crystals when revolatilized.
(2) None are soluble in hypochlorite of soda.

(3) Having been treated as directed (F) with nitro-hydrochloric acid, none give a red precipitate with nitrate of silver.

7. Dissolve some chloride of tin in hydrochloric acid, and heat to boiling. The solution should be colourless. The merest trace of arsenious acid added to this solution produces a brown black precipitate of metallic arsenic. Antimony gives no result with this test (Bettendorff).

II. *For Arsenious Acid in Solution.*

1. The solution is tasteless or nearly so.

2. It is feebly acid to litmus (reaction noticeable with 1 part in 1000 of water).

3. The solution when evaporated to dryness leaves octahedral crystals which may be completely volatilized by the continued application of heat.

4. The following reactions should be noted, but they are unimportant as tests, because of their numerous fallacies :—

Lime water gives a white precipitate, soluble in hydrochloric acid.

Iodide of potassium gives a white precipitate, which becomes yellow on the addition of hydrochloric acid.

Bichromate of potash gives a green precipitate.

Boiled with *caustic potash* and a *drop of a solution of sulphate of copper* added, a red precipitate of the suboxide is produced. A similar action occurs with grape sugar. A very little sulphate of copper must be added, otherwise the black protoxide will be thrown down which masks the red colour of the suboxide.

The following tests are of importance :—

5. *Ammonio Nitrate of Silver* (Hume's Test, 1789). The reagent must be prepared fresh each time it is required. (*Preparation:* Add, drop by drop, a weak solution of ammonia to a solution of nitrate of silver, until the brown precipitate first produced is *nearly* dissolved; decant the clear liquid. There must be enough ammonia, otherwise a yellow precipitate will be produced with alkaline phosphates and silicates, but not too much, otherwise no precipitate is formed with arsenious acid.)

This solution produces a bright yellow crystalline precipitate of arsenite of silver ($Ag_3\,As\,O_3$) with arsenious acid solutions. The precipitate is soluble in ammonia and in dilute acids, but insoluble in the fixed caustic alkalies. It is decomposed by hydrochloric acid, chloride of silver being formed. It changes to a greenish brown colour by the action of sunlight.

The precipitate must be collected and heated with a reducing agent. In this way a sublimate of metallic arsenic will be obtained, from which sublimate the octahedral crystals of arsenious acid may be produced by repeated volatilizations in a free supply of air.

Fallacies:

A yellow precipitate is produced with *free phosphoric acid*, which is soluble in ammonia and nitric acid.

A yellow precipitate is produced with *vanadic acid.*

A yellow precipitate is also produced with *alkaline iodides and bromides*, which is insoluble in dilute nitric acid, and only slightly soluble in ammonia.

None of these precipitates, however, yield sublimates resembling those of metallic arsenic or of arsenious acid.

NOTE.—This test is not applicable to solutions containing organic matter, as it decomposes the test reagent.

6. *Ammonio Sulphate of Copper* (Scheele's Test).

(*Preparation.*—Add drop by drop ammonia solution to a weak solution of sulphate of copper, until the precipitate first produced is nearly dissolved. Decant the clear liquid. The test is to be prepared fresh each time it is required.)

It produces with a solution of arsenious acid a light apple green precipitate of arsenite of copper (Scheele's green: $Cu\ H,\ As\ O_3$), which is soluble in ammonia and dilute acids. If the solution is weak, the precipitate is some time in appearing. Sulphate of copper alone gives similar precipitates with solutions of *neutral* arsenites.

Collect the arsenite of copper and test as follows:—

(*a*) Heat a small quantity in a reduction tube with a reducing agent, and by this means obtain a metallic sublimate, which must afterwards be oxidized by repeated volatilizations.

(*b*) Dissolve the remainder of the arsenite in hydrochloric acid and divide into two parts (1 and 2).

(1) Pass sulphuretted hydrogen through the solution, collect the precipitate, dissolve in ammonia, and filter; neutralize the filtrate with hydrochloric acid, when the sulphide will be again precipitated.

(2) Test the remainder of the acid solution by boiling in it some strips of clean copper.

Fallacies: no metallic substance is likely to be a source of error, but various organic substances, such as tea, coffee, &c., give a somewhat similar precipitate.

7. *Sulphuretted Hydrogen* (H_2S).

Gives with an arsenious acid solution, acidulated with hydrochloric acid, a bright yellow amorphous precipitate of orpiment ($As_2\ S_3$).

Note—

A. The precipitate is not produced in an alkaline solution. Hence sulphide of ammonium should not be used, although the arsenic can be afterwards precipitated by the addition of hydrochloric acid. It must, however, be remembered that acids precipitate sulphur, which has more than once been mistaken for orpiment from the similarity of the colour.

B. The sulphuretted hydrogen should always be passed through a wash bottle before passing it through the solution to be tested (fig. 4).

C. The hydrochloric acid used in the experiment must be pure and free from arsenic.

D. Dr. Taylor says the precipitation is aided by the addition of a solution of chloride of ammonium.

E. If the arsenious acid solution be very dilute, it will be advisable before collecting the precipitate, to get rid of the excess of sulphuretted hydrogen by heating the solution.

F. When organic matter is present, the precipitate often appears of a dull yellow colour.

G. If sulphate of copper has been given as an emetic, the black colour of the copper precipitate may obscure the yellow colour of the arsenic. In such a case filter off the precipitate, digest in ammonia, filter, and evaporate down the ammoniacal solution, when the residue will show the yellow colour of the orpiment.

The sulphide of arsenic is *insoluble* in cold hydrochloric acid, and but very slightly soluble in hot; but it is *soluble* in nitric acid (by which it is changed into arsenic acid) and also in caustic alkalies, and in alkaline sulphides and carbonates.

Memo:—Sulphuretted hydrogen gives a bright yellow precipitate with CADMIUM in weak acid solutions, the precipitate being *soluble* in hydrochloric acid, but *insoluble* in alkalies.

It gives with SELENIOUS ACID in neutral or alkaline solutions a yellow precipitate changing to red, the precipitate being *insoluble* either in hydrochloric acid or in ammonia.

It gives with TIN a dull yellow precipitate either in acid or neutral solutions, the precipitate being sparingly *soluble* in ammonia.

It gives with ANTIMONY an orange red precipitate, either in acid, neutral or alkaline solutions, the precipitate being *soluble* in cold concentrated hydrochloric acid, very soluble in caustic potash, but nearly *insoluble* in ammonia. (An hydrochloric acid solution, boiled with a piece of copper foil, produces a violet-coloured metallic deposit, which may be known from arsenic by not yielding octahedral crystals.)

You have now to prove the yellow precipitate produced by sulphuretted hydrogen is an *arsenical sulphide*. Note as follows:—

1. It is insoluble in water or in hydrochloric acid.
2. It is soluble in ammonia solution and in solutions of caustic potash and soda.
3. Dry and heat a portion of the sulphide with a reducing flux of carbonate of sodium and charcoal in a reduction tube, and so obtain—
   - (*a*) A metallic sublimate.
   - (*b*) Octahedral crystals of arsenious acid by repeated volatilizations in the presence of air.

4. Dissolve a portion of the precipitate in hot nitric acid. Evaporate to dryness, and, the residue being neutral, add a few drops of a strong solution of nitrate of silver, when a brick-dust precipitate of arsenate of silver will be formed ($Ag_3 As O_4$).

8. *Marsh's Test.* (Mr. Marsh of Woolwich, 1836.)

(Depending on the property of nascent hydrogen to combine with arsenic to form arseniuretted hydrogen, $As H_3$.)

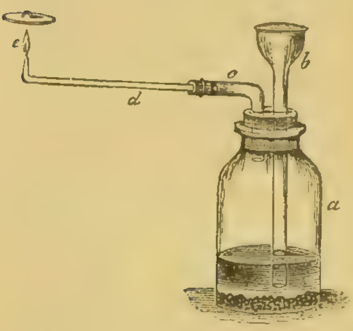
Arseniuretted hydrogen (s. g. 2·695), is a colourless gas having a garlic odour, very poisonous, sparingly soluble in water, burning with a bluish flame, and being readily decomposed by heat into arsenicum and free hydrogen :—

To make the experiment proceed as follows :—

An apparatus must be arranged as below, new bottles and tubes being used for each experiment (fig. 15).

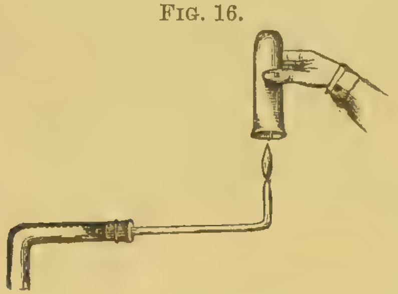
Generate hydrogen in the bottle (*a*) by the action of pure dilute sulphuric acid on pure zinc. If the hydrogen be difficult to get off, as it will often be found to be when pure zinc is used, a few little pieces of platinum dropped into the bottle will remedy the difficulty. Prove the absence of any arsenic in the reagents, first of all, by generating the gas for some fifteen minutes, and testing as directed. If all the materials be thus proved to be pure, then pour the arsenical liquid to be examined, into the bottle where the hydrogen is being generated. The gas (which will now be arseniuretted hydrogen) will be found to come off much faster than the pure hydrogen did before the addition of the arsenical solution. Ignite the gas. Note—

FIG. 15.



A. *The Jet*—This is much increased in size by the addition of the arsenic. (The hydrogen, therefore, should be generated very slowly before the arsenic is added.) The flame becomes of a blue tint, has a garlic odour, and may possibly give off a thick white smoke ($As_2 O_3$), which may be collected (fig. 16). (The flame of antimoniuretted hydrogen is without smell and of a green colour.)

FIG. 16.



B. Hold a slip of cold porcelain near the point of the flame (*e*), when a crust of metallic arsenic will form upon it. Several of these deposits should be obtained, and they will be found to possess the following characters. The centre part has a brilliantly metallic lustre, and is surrounded by a dark ring (probably a suboxide of the metal ; *Odling*) ; outside this, either a white ring of arsenious acid, or a brownish ring formed by a mixture of the metal and arsenious acid, will be found.

To prove this stain is arsenical. Note—

(*α*) Its metallic brilliancy.
(*β*) Its hair-brown colour. This is best seen by transmitted light.
(*γ*) Its volatility. The stain is dissipated, and arsenious acid produced, when it is heated even below redness.
(*δ*) Its solubility when warmed in a solution of chloride of lime.
(*ε*) No apparent action results when the stain is first treated with sulphide of ammonium, but if heat be applied to the mixture, a yellow stain having a metallic centre will be formed.

(ζ) Warm the stain with a drop or two of nitro-muriatic acid and evaporate to dryness ; the residue may be proved to be arsenic acid by the production of the peculiar brick-dust precipitate of arsenate of silver on the addition of nitrate of silver.

(η) It is not acted upon by a solution of protochloride of tin.

The authors consider it very doubtful that any difficulty or fallacy can arise (as some have suggested) from the presence in the arsenical solution of iron, phosphorus, or sulphur.

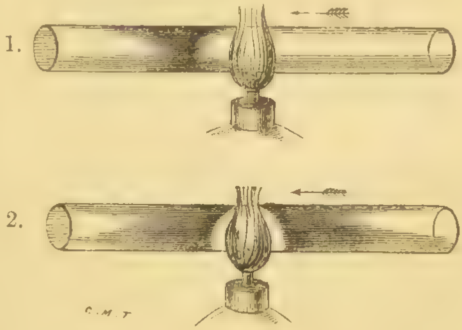
Note the following points of difference in the re-actions of a crust of metallic arsenic and of metallic antimony.

ARSENIC.	ANTIMONY.
1. Acted on *very slowly* by sulphide of ammonium.	1. Dissolved *rapidly* by sulphide of ammonium.
2. This mixture (1) evaporated to dryness gives a *bright yellow* deposit,— Soluble in ammonia ; Insoluble in hydrochloric acid.	2. This mixture (1) evaporated to dryness gives *an orange red* deposit,— Insoluble in ammonia ; Soluble in hydrochloric acid.
3. It is very soluble in a solution of chloride of lime.	3. It is very slightly and slowly soluble in a solution of chloride of lime.
4. It is soluble in warm nitric acid ; and this, on being evaporated to dryness, leaves a white residue. Add *nitrate of silver*, and a *brick-red precipitate is produced.*	4. It is soluble in warm nitric acid ; and this, on being evaporated to dryness, leaves a white residue. Add *nitrate of silver* and *no action results.*
5. It is not dissolved by a solution of protochloride of tin.	6. It is dissolved slowly by a solution of protochloride of tin.

C. Heat the tube at *d* (fig. 15) to a red heat, when the gas will be decomposed and a steel-grey ring of metallic arsenic be formed at some little distance *beyond* the flame (Berzelius). (It is better that the tube should be red-hot before the arsenical solution is introduced.)

Note the following differences between the stain produced by arseniuretted hydrogen and that produced by antimoniuretted hydrogen under similar circumstances :

FIG. 17.



1. To produce the arsenical stain a higher temperature is needed than is required to produce the antimonial from their respective hydrogen compounds.

2. The *arsenical* stain is deposited at a short distance from the source of heat (fig. 17 (1)). The *antimonial* stain is deposited close to, and on both sides of it (2).

3. The *arsenical* stain readily volatilizes by the application of heat, recondensing a little further on in the tube, octahedral crystals of As_2O_3 being formed. The *antimonial* stain volatilizes with difficulty, and yields a white amorphous precipitate very near to the spot where the heat is applied.

4. The *arsenical* stain is soluble in a solution of chlorinated lime the *antimonial* being insoluble.
5. Similar tests are to be applied to these stains as already described (page 144).

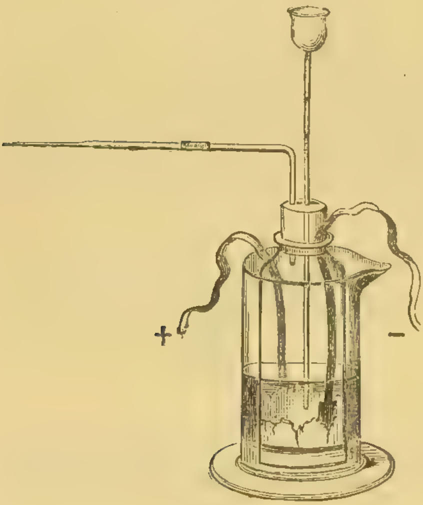
D. Pass the gas slowly through a weak solution of nitrate of silver, when a black precipitate of *metallic silver* will be produced. Precipitate the excess of silver with hydrochloric acid, filter, and either

(1) Evaporate the filtrate to dryness and test the residue for arsenic acid with nitrate of silver; or
(2) Treat the filtrate with sulphuretted hydrogen. If the quantity be sufficient, try both tests.

(Note—If the silver solution should become *suddenly* black, this may be due to sulphur compounds. which you would know are being set free by testing the action of the gas on lead paper.)

E. Sometimes it is convenient to pass the arseniuretted hydrogen into nitric acid containing a little sulphuric acid. This may afterwards be evaporated to dryness, and tested for arsenic acid with nitrate of silver.

FIG. 18.



It must not be forgotten that not only the zinc but also the oil of vitriol of commerce often contains arsenic, from the pyrites used in its preparation. Roussin recommended the use of magnesium in the place of zinc, and Morton ("Lancet," Jan. 16th and June 12th, 1841, pp. 585 and 394) has suggested utilising for the experiment the hydrogen developed during the decomposition of water by the galvanic battery.

The above figure (fig. 18) represents the form of apparatus recommended by Bloxam, and needs only a word of explanation. A 2-oz. bottle has its bottom replaced by a parchment covering, secured round the bottle with platinum wire. This is placed in another glass, and the whole apparatus kept cool by being immersed in a vessel containing cold water. Two pieces of platinum foil connected with platinum wires, are placed one in the bottle and one in the vessel external to the bottle. The one *in* the bottle is to be connected with the *negative* pole of the battery from which the hydrogen is generated, and the other with the positive pole. Both the vessel and the bottle are to be filled half full with dilute sulphuric acid (one to three of water). When the absence of arsenic has been clearly ascertained, the liquid to be tested may be poured through the funnel into the bottle. All the re-actions already described can thus be obtained. The frothing which sometimes occurs can be kept in check by the addition of a little alcohol.

The delicacy of Marsh's test is very great.

Should the arsenic exist as arsenic acid, or as a salt of arsenic acid, no arseniuretted hydrogen will be generated. It is then necessary to heat the arsenic acid with sulphite of soda, and so reduce it to the lower grade of oxidation, when the re-actions described may be obtained.

9. *Reinsch's Test* (1843).

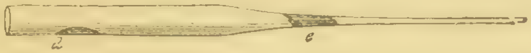
(Depending on the deposit of the metal on copper when boiled in a hydrochloric acid solution.)

Boil the solution of arsenious acid with about one-sixth its bulk of pure hydrochloric acid, and place in the mixture one or two pieces of well-cleaned, bright, pure copper foil.

The copper is to be cleaned by first heating it in a Bunsen burner, and, after acting upon it with a little nitric acid in a test tube until it is perfectly bright, thoroughly washing with water.

The copper will, after a short time, acquire a steel-like metallic coating, which will be found, if the solution is boiled too long, or the arsenic be in large quantity, to peel off readily from the copper. If the arsenic is only present in very small quantity, the deposit is thin and of a violet tint. The coating is believed to be an alloy of arsenic and copper (Lippert). The delicacy of this test is very great, and although it is, perhaps, not so delicate as Marsh's test, it is in our opinion far more useful for general work.

FIG. 19.



The following points in the experiment demand attention :—

1. The hydrochloric acid and the copper must themselves be proved to be free from arsenic.

2. At the commencement of the experiment, the smaller the piece of copper foil that is introduced the better; but if the first piece becomes coated, then piece after piece should be added until the last piece remains bright.

3. Before you decide the absence of arsenic, boil the copper with the acid solution for at least half an hour, as the liquid may possibly deposit arsenic on the copper as it becomes more concentrated.

4. Copper will sometimes become somewhat dingy after prolonged boiling in an acid liquid containing organic matter. This dinginess must not be mistaken for an arsenical deposit.

And now remove the copper strips from the solution, wash them with a little pure water from a wash bottle, and dry by pressing them very gently between folds of blotting paper.

You must now prove that the deposit on the copper is arsenic.

Note—

1. The steel-grey colour of the deposit.

2. Coil up the pieces of copper and put them into a *dry* clean reduction tube; (*dry*, because the deposition of moisture might possibly be deceptive.) Heat them, and in this manner the octahedral crystals

of arsenious acid will be obtained. The size of the reduction tube used must depend on the quantity of the deposit. If it be only very small, a tube drawn out somewhat finely will be best (fig. 19), the sublimate being allowed to form in the narrowed portion of the tube.

3. Proceed to test these crystals of arsenious acid as already described by the liquid tests after dissolving them by boiling with water.

This test is *not applicable* when oxidising bodies are present. Free nitric acid, excess of nitrates, or the presence of a chlorate are therefore impediments.

The possible *fallacies* are important—Antimony, mercury, silver, bismuth, platinum, palladium, tin and gold are deposited on copper when boiled in an acid solution, whilst the dingy tarnish that copper acquires when boiled in an acid liquid containing organic matter (especially if it contains sulphur) has already been noted. The *antimony* deposit is violet; the *mercury*, *silver*, and *bismuth* deposits are bright and silvery; the *gold* is yellow, whilst the *platinum* and *palladium* deposits have a great resemblance to arsenic. Two only of these deposits, however, besides arsenic, viz., antimony and mercury, yield a sublimate when heated in a reduction tube.

(*α*) The sublimate from *antimony* is amorphous, and insoluble in water.

(*β*) The sublimate from *mercury* consists of bright metallic globules insoluble in water.

(*γ*) The sublimate from *arsenic* consists of octahedral crystals, sparingly soluble in water. The presence of these octahedral crystals is decisive.

Lastly, tartar emetic often contains a trace of arsenic. Hence if tartar emetic has been given to produce vomiting or as a medicine, the possibility of obtaining a mixed sublimate must not be overlooked.

Toxicological Analysis.

In conducting a toxicological investigation—

1. Note that inasmuch as white arsenic is only very sparingly soluble in the fluids of the digestive tract, solid white particles should be carefully looked for with a powerful magnifying glass both in the contents, and on the coats of the stomach, scraping them for this purpose here and there with the handle of a scalpel. It must not be concluded that every white powder so found is arsenic (such mistakes have been made), but it should, if found, be carefully removed, cleaned, and tested. Note further whether the arsenic is in lumps or in fine powder.

2. Carefully look for soot or indigo with which the arsenic may have been mixed.

3. Remember that white arsenic, as the body putrefies, may pass partially or completely into the state of yellow sulphide. If solid arsenic is found it is *absolutely* certain it was taken in a *solid* state, but if otherwise, it may then have been taken either as a solid or in solution.

4. In cases of suspected arsenical poisoning, examine, if possible, particularly the urine, the liver and the spleen. In these the largest quantity will probably be found, and possibly when none can be discovered in other parts.

As regards the elimination of the poison by the urine, M. Lafonde's experiments prove that the time which elapses between the administration of the arsenic and its detection in the urine is never less than one, or more than seven hours. ("Lancet," 1845, vol. ii., p. 269.)

Further, it is worth noting that Dr. Legroux found the serum from a blister of a patient who had taken arsenic gave distinct evidences of the presence of the poison. ("Med. Times," Oct. 9, 1847, p. 652.)

A. Cut up the tissues, to be examined, very fine, and as far as possible break them up in a mortar. Dilute these, together with any organic liquids such as the contents of the stomach, with sufficient distilled water that they may filter easily. Acidulate with hydrochloric acid, and set the whole aside for some hours in a warm place. Filter. Divide the filtrate into two parts (α and β).

- (α) Through one part pass *for some time* a stream of washed sulphuretted hydrogen. Collect the precipitate and test (see tests).
- (β) The other half is to be examined by Reinsch's process (see tests).

All the solid materials on the filter paper are now to be well mixed with dilute hydrochloric acid (one of acid to two of water) gently boiled, then filtered, and the filtrate tested by Reinsch's process (see tests).

Vomited and other matters may be similarly examined.

B. The following is a process which, at times, may be found useful.

Acidulate the contents of the stomach with acetic acid, add distilled water and boil; filter; again and again boil in fresh acidulated water and filter. Mix these filtrates together, and divide them into two equal parts (1 and 2).

(1) Evaporate the one part nearly to dryness, and heat until quite charred with twice its bulk of sulphuric acid. Dilute the mixture with water, and little by little pour it into a Wolfe's bottle in which hydrogen is being slowly evolved from pure zinc and dilute sulphuric acid. Pass the gas by means of a bent tube drawn out at its end through a solution of nitrate of silver, when a black precipitate will be thrown down. (The gas must only be allowed to pass slowly.) When no more gas comes over, add to the black silver solution hydrochloric acid in slight excess, in order to precipitate the remainder of the silver—boil for a few minutes, filter, and evaporate the filtrate to dryness. Dissolve any residue in distilled water, and carefully precipitate the arsenic acid as arsenate of silver with ammonio-nitrate of silver (451·51 grs. = 100 grs. of arsenious acid).

Heated with black flux or charcoal this arsenate of silver may be reduced, the metallic sublimate being preserved for evidence.

(2) Slightly acidulate the second part with hydrochloric acid, and boil the solution with some clean strips of copper that have been previously weighed. After boiling for some time remove the pieces of copper, dry, and again weigh—the increase of weight being noted. They are then to be heated in a tube and the metal sublimed, the weight of the copper, less the arsenicum, being again noted. In this way the quantity of arsenic present may be estimated.

Several other processes are recommended by some toxicologists, and these (without ourselves recommending them) we must briefly notice.

C. (*Process of Fresenius and Von Babo.*)—Cut the tissues up very fine, and mix them with an equal weight of hydrochloric acid. Heat on a water bath. Add twenty grains of chlorate of potash and stir well. Repeat the dose of chlorate of potash from time to time until the organic matter is entirely destroyed, which may be known by the light yellow colour the solution will assume. Continue the heat until all odour of chlorine has disappeared. Strain the materials. Any arsenic now exists in the solution as arsenic acid—($As_2 O_5$).

Reduce the arsenic acid ($As_2 O_5$) to arsenious acid ($As_2 O_3$) by boiling with sulphite of sodium.

Add to the solution hydrochloric acid, and pass sulphuretted hydrogen through it. Collect the precipitate by allowing it to stand, and then pouring off the supernatant liquid. Act on this with a little water and with strong ammonia; (mercury, copper, antimony, and lead will not be dissolved). Filter the solution, and wash the matters on the filter paper with ammonia water. The filtrate will contain the arsenic, the solution being generally pure enough to be at once tested.

The precipitate on the filter paper may then be examined for other substances.

Take care previously, however, carefully to examine the chlorate of potash for arsenic. This can easily be done by passing sulphuretted hydrogen through the solution of the salt, or by adding to it a solution either of ammoniacal sulphate of copper (green) or of ammoniacal nitrate of silver (yellow).—0·002 part of a grain of arsenic in a fluid ounce of a solution containing six per cent. of chlorate of potash can in this way be easily detected. *Reinsch's test* cannot be used, because the gases evolved (chlorine and chloric oxide) by the action of hydrochloric acid on the salt at a boiling temperature dissolve the copper. *Marsh's test* may be used. For this purpose treat the solution with sulphuric acid drop by drop until about one-tenth part by volume has been added. With this solution hydrogen may be set free by acting on pure zinc, and the gas tested as usual.

The great objections to Fresenius and Von Babo's test for arsenic is (1) that both the re-agents used (chlorate of potash and hydrochloric acid) may contain the poison, and (2) that the chlorine and chloric oxide evolved, carry away with them a large portion of arsenic in the form of a volatile chloride. Except under special circumstances we consider its use unadvisible.

D. (*Process of Danger and Flandin.*)—Cut up the tissues very fine. Act upon them with one-fourth their weight of concentrated sulphuric acid, and heat until the materials are thoroughly dry and charred. Treat the mass with boiling water acidulated with nitric acid, and evaporate to dryness, the residue being once more treated with dilute nitric acid, and again evaporated to dryness. Act now on the residue with water, and neutralize the solution with carbonate of soda. Evaporate to dryness, and having added to the residue a few drops of sulphuric acid, dissolve the arsenate of soda (as it now exists) in a little hot water. Reduce the arsenic salt with sulphite of sodium, and examine the solution with sulphuretted hydrogen and by Marsh's test.

Throughout this process the distillates should be preserved and examined for arsenic.

E. (*Odling.*)—Thoroughly dry the tissue. Treat the mass with an equal weight of the strongest hydrochloric acid, and place it in a retort fitted with a Liebig's condenser, and connected with a well-cooled receiver containing a little water. Distil to dryness, and test the distillate for arsenic by the several tests described. This method will serve to detect arsenic in all its forms, except when it exists as an insoluble sulphide. The process depends on the extreme volatility of the chloride of arsenicum. Chloride of antimony is difficult to obtain by distillation, whilst the chlorides of lead, copper, mercury, &c., are not volatile.

Test the distillate by Marsh's test (page 143), by Reinsch's test (page 147), and by Bettendorff's test (page 141).

It is necessary here to note a few important facts—

1. Arsenic is not as Orfila supposed a normal constituent of the body. Orfila's mistakes were due, as he afterwards admitted, to the use of an impure pyritic sulphuric acid.

2. If a large quantity of arsenic is found after death, a large dose must have been taken; but, on the other hand, a very small quantity only may be found, and yet a large dose may have been taken. The quantity found after death, therefore, often gives no data by which to judge of the amount taken by the deceased.

3. After about fourteen days, if the patient lives as long, the arsenic will probably have entirely passed out of the system and none be able to be detected in the viscera after death.

Its entire evacuation may be effected according to Dr. Taylor, even after eight hours, whilst on the other hand, the period of its detention may possibly be protracted. At any rate this is certain, if the poison is in the body at death, it is never lost. It has been found after fourteen and more years. (*Vide* the "Lancet," Jan. 20, 1838, p. 593, case of the widow Lamothe.)

4. The quantity of the poison is estimated in the form of sulphide—

$$100 \text{ grs. of } As_2\,S_3\text{—}80{\cdot}48 \text{ of } As_2\,O_3.$$

5. Arsenic reacts on Trommer's test similarly to grape sugar, hence it is important not to confound the two.

6. It has been stated by French toxicologists that in some cases of exhumation, where arsenic was afterwards proved to be the cause of death, a peculiar alliaceous smell was noticeable, which was attributed by them to the development of arseniuretted hydrogen. This very probably is a mistake, and it certainly is not usually to be noticed in such cases.

7. In exhumation cases, it is always advisable to examine some of the soil of the cemetery, which may contain arsenic, from its geological constitution. The quantity, if any be present, should be carefully estimated. ("Medical Times," July 27, 1844, p. 216.)

8. It may be advisable to examine all the antidotes that were administered, if arsenic be found, in order to meet possible objections.

Arsenites of Soda and Potash.

Both the arsenites of soda and of potash (liquor arsenicalis or liquor Fowleri, "tasteless ague drop") are very poisonous. The arsenite of soda is used for cleaning metal, and has upon several occasions preduced fatal results. What is known as "fly water" is generally a solution of the mixed arsenites of potash and soda.

Arsenite of Copper ($Cu\,H\,As\,O_3$)
(Scheele's Green).

The copper arsenite is a green pigment and is largely used in the arts and manufactures, numerous shades being produced by its admixture with whitening or with zinc oxide. It is insoluble in water, but soluble to a certain extent in the fluids of the digestive tract.

Very bad effects have resulted from its use. It is largely used for paper hangings, and if these be unglazed the danger is considerable. ("Lancet," April 26, 1862, p. 445—November 8, 1862, p. 517—January 31, 1874, p. 175. "Medical Times and Gazette," 1857, vol. i., pp. 177 and 520.) On more than one occasion we have found arsenic on the dust of books in a library hung with a green paper. The authors have found as much as thirty-five grains of arsenious acid on a square foot of paper. Poisoning symptoms have been produced in workmen by merely unpacking the green papers ("Medical Times and Gazette," May 10, 1862, p. 497), whilst the paper-hangers often suffer severely from skin eruptions, especially on the scrotum, from œdema of the face, and in advanced stages from all the symptoms of arsenical poisoning. The evil effects are not so much due to the volatility of the arsenic, as some have imagined, although it is quite possible this may partially be a cause of the evil, but chiefly to the mechanical suspension of arsenical dust in the air of the room. Arsenical symptoms, too, have been produced, in ballet dancers through wearing green dresses ("Medical Times and Gazette," April 11, 1863, p. 374), by the use of green artificial flowers ("Medical Times and Gazette," November 30, 1861, p. 560), by the use of the arsenite to colour air balls ("Medical Times and Gazette," May 22, 1858, p. 529), by sucking green coloured wafers ("Medical Times," November 13, 1847, p. 79) and by its use in confectionery ("Lancet," February 17, 1849, p. 191, and January 22, 1853, p. 100, and January 31, 1874, p. 175. See also Dr. Letheby's report on arsenical flowers and dresses, "British Medical Journal," October 25, 1862, p. 448.) No metallic colouring matter, whatever they may be, or however small the quantity, should be used in confectionery. Nor is there any need for it. We have lately examined some magnificent vegetable colouring matters (prepared chiefly from quercitron bark and Persian berries) manufactured by Mr. Bush of Liverpool Street. What is called Schweinfurt, emerald, or mineral green is also largely used as a pigment. This is a double salt of arsenite and acetate of copper. A case is recorded of poisoning symptoms being induced by merely handling and powdering cakes of this substance ("Lancet," December 14, 1872, p. 854.)

The symptoms produced by arsenical wall and dress pigments are those of alteration in the blood and disturbance of the central nervous system. They are essentially the action of the arsenic and not of the copper (see paper by Dr. Kirchgässer of Coblenz Vierteljahrschr, ix., p. 96), and may often be found well marked in dressmakers who work at coloured fabrics, as well as in the ladies who wear them constantly. The eyes and eyelids are generally first of all affected, the patient complaining of great debility, irritation, and dryness of the throat, perhaps even of diphtheritic symptoms, a constant hawking up of viscid purulent sputa, cold sweats, nausea, colicky pains and rumbling in the bowels, more or less feverishness of an intermittent character, cramps in the legs and hands, epigastric tenderness, sometimes salivation with even purulent saliva, and the symptoms of irritation of the mucous membranes generally. A green or clay coloured tinge may often be noticed over the skin, with brownish spots on the forehead and cheeks. Sometimes urticaria supervenes. The hair frequently drops off. There is usually painful micturition, arsenic being found in the urine in six out of every eight cases. The liver is the part which is generally the most affected, whilst not uncommonly more or less severe jaundice occurs.

Dr. Guy gives the particulars of a fatal case, and has described with singular accuracy the eruption of the skin that is often met with. It is in the first instance a papular rash running on to pustulation, appearing about the root of the nostrils, on the bends of the ears, elbow, thighs, &c., but especially on the scrotum, where superficial ulcers may be found, varying in size from a split pea to that of a fourpenny piece, whilst sometimes the fingers will be found inflamed and the nails dropping off. A case is recorded of peculiar ulcerations on the anus being produced by the local use of a green paper dyed with arsenite of copper ("Lancet," July 12, 1873, p. 49).

Lastly, arsenite of copper has been given with the view of procuring abortion, but its action is questionable. It would appear that the nervous symptoms produced when it is given internally are the chief points of interest in these cases. There is great irritability, loss of memory, faintings, quiverings of the muscles, and in some cases partial paralysis of the extremities, the muscles retaining, however, their susceptibility to the action of the electric current. The extent to which sensation is affected is not usually great. The touch and hearing are sometimes impaired, but not usually the sight. Headache is often troublesome.

Tests.

(1) Act on some of the colouring matter with a strong ammonia solution, when it becomes of a deep blue colour. Pour this blue solution over a crystal of nitrate of silver in a white capsule, and note that a yellow arsenite of silver is formed on the surface of the crystal. (Taylor.)

(2) Dissolve some chloride of tin in hydrochloric acid; heat to boiling. Add to this a small quantity of the colouring matter, when the metallic arsenic will be precipitated of a brown colour.

(3) Dissolve some of the colouring matter in hydrochloric acid, and test by Marsh's test.

(4) Or any other tests for arsenic may be used.

The post-mortem appearances and treatment are those described under arsenious acid.

Arsenic Acid (As_2O_5) *and the Alkaline Arsenates.*

Arsenic acid is a white deliquescent solid, without smell, and soluble in water.

It has a very acid re-action, and is reduced by the action either of a sulphite or of sulphurous acid to arsenious acid. At a red heat it fuses and evolves oxygen. It is used as an oxidising agent in the manufacture of aniline colours. This is the explanation of many of the cases of eruption caused by the use of magenta coloured socks and other wearing apparel. (See "British Medical Journal," Nov. 21, 1874, p. 643. "Medical Times and Gazette, Feb. 27, 1869, and April 17, 1869.) Nor should it be forgotten that red liqueurs are occasionally coloured with magenta. There are no cases on record of poisoning with arsenic acid in the free state in the human subject. Dr. Glover relates a case where a rabbit was poisoned with four grains in four hours. The alkaline arsenates are soluble in water, but the metallic arsenates are insoluble. The alkaline arsenates are active poisons. Christison relates two cases of poisoning with them. The arsenate of soda is used in France as a medicine. "*Pearson's solution*" is a solution of the arsenate of soda (1 gr. to ℥j. of water). "*Macquir's neutral arsenical salt*" is a binarsenate of potash. The well-known "papier moure" consists of paper soaked in a solution of arsenate of potash.

Tests for Arsenic Acid.

(1) It is not entirely volatilized by heat.

(2) A sublimate of metallic arsenic is produced by heating the acid or its compounds with a reducing agent.

(3) *Nitrate of silver* gives a reddish brown precipitate, which is soluble in nitric acid and in ammonia, but is insoluble in acetic acid.

(4) *Sulphuretted hydrogen* gives no immediate precipitate with arsenic acid even in concentrated solution, as it does with arsenious acid, but after some time a light yellow precipitate falls which is insoluble in hydrochloric acid, soluble in ammonia and its carbonate, and yields a metallic sublimate when heated with reducing agents. (Hence, it is advisable before treating an arsenic acid solution with H_2S, to reduce the arsenic acid to arsenious acid by treating it with sulphurous acid gas, or by heating with sulphite of soda.)

(5) *Ammonio-sulphate of magnesia* (made by precipitating sulphate of magnesia with ammonia, chloride of ammonium being added to dissolve any precipitate that may form) produces with arsenic acid a precipitate of ammonio-arsenate of magnesia (NH_4MgAsO_4), which is soluble in nitric, hydrochloric, and acetic acids, and sparingly soluble in ammonia. (This re-agent does not precipitate arsenious acid, but it does phosphoric acid.) To prove the precipitate is arsenical it should be boiled in hydrochloric acid with some strips of bright copper foil.

(6) With *Reinsch's test* arsenic acid gives on copper an iron grey deposit, but the deposit is not nearly so characteristic as that produced with arsenious acid.

(7) *Ammonio-sulphate of copper* produces a greenish blue precipitate soluble in ammonia, in nitric, and in excess of free arsenic acid.

Arsenic acid is best estimated as ammonio arsenate of magnesia: 100 grs. = 63·53 of arsenic acid.

Orpiment (As_2S_3).

(Sulphide of arsenic; yellow arsenic; King's yellow.)

This being a bright yellow pigment is largely used for colouring purposes. It has been used by mistake for turmeric, in colouring confectionery, and with fatal results. It is important to remember that white arsenic is converted into orpiment in the body, but that orpiment cannot be changed back into white arsenic. Orpiment owes its poisonous properties to the variable proportions of white arsenic that it contains. As much as 79 per cent. is reported to have been found.

In conducting a toxicological examination—

1. Examine the stomach for the characteristic colour of the poison.
2. Dissolve the powder in ammonia and reprecipitate with hydrochloric acid.
3. Examine this precipitate (*vide* page 143) as directed.
4. If much organic matter be mixed with it, heat the materials with strong nitric acid to dryness, thus converting it into arsenic acid, and proceed accordingly (page 143).

Realgar ($As_2 S_2$).

(Red arsenic; sandaracha.)

Used also as a colouring matter, and is very poisonous.

Chloride of Arsenic ($As\,Cl_5$.)

This is prepared by dissolving arsenic in dilute hydrochloric acid, and was originally used in medicine. It is very poisonous.

Arseniuretted Hydrogen ($As\,H_3$). (Page 143.)

This is a very poisonous gaseous compound, and probably the most dangerous of all the compounds of arsenicum.

It has proved fatal in several cases. It is inflammable, and may easily be detected in other gases by Marsh's test (page 143).

Iodide of Arsenicum ($As\,I_3$).

This is prepared either by triturating the metal with dry iodine aiding combination with slight heat—or by boiling the metal with iodine for some time.

It has a brick red colour, no smell, but a strong metallic taste. It sublimes readily. It is soluble in a large bulk of water, forming an acid lemon-coloured solution, which becomes deep brown on prolonged exposure to air. It is decomposed if thrown into water, provided the quantity be insufficient for its solution. It is readily decomposed by mineral acids.

Its physiological action in poisonous doses is very similar to arsenious acid. It is also a cumulative poison.

In Dr. A. Todd Thomson's experiments ("Lancet," October 27, 1838, p. 180) one dram killed a dog in two and a half hours, the œsophagus being tied, the symptoms (pain, convulsions, emprosthotonos, and at last insensibility) setting in after four minutes. Half a dram, dissolved in four ounces of water, injected into the abdominal cavity of a dog, killed it in about twelve minutes. A similar quantity injected into the thorax killed n fifteen minutes; forty grains killed a dog when it was inserted into a wound, and fifteen grains injected into the jugular vein killed in twenty seconds. Given by the mouth (the œsophagus not being tied) the animal vomited the poison and recovered.

The post-mortem appearances show, that the iodide softens and gelatinizes the mucous membrane of the stomach, and occasionally causes ulceration. It may be found after administration in all the secretions, even in the milk. Dr. A. T. Thomson believed it to be, in small doses, a very valuable medicine.

Cases of Poisoning by Arsenic and Arsenical Compounds.

(I.) ARSENIOUS ACID.

1. "Lancet," Feb. 1, 1840, p. 706. Female : æt. 25 (?) A pennyworth (?).		
Symptoms.—In 2 hours nausea and pain.	*Result.*—Death on 4th day.	*Post-mortem.*—Stomach externally appeared white, but internally was softened and ulcerated; intestines inflamed ; liver soft.
2. "Lancet," Dec. 7, 1839, p. 416 (Dr. Burne). Female: adult. Four pills, each containing $\frac{1}{20}$th of a grain, taken during four days.		
Symptoms.—On the 4th day inflammation of the stomach; delirium; swimming of eyes, and exhaustion.	*Result.*—Recovery.	
3. "Lancet," May 15, 1841, p. 315 (Mr. Michael Foster). Female : æt. 37. Dose (?).		
Symptoms.—Local action not excessive; but nervous excitement intense.	*Result.*—Death in 3½ hours.	*Post-mortem.*—Stomach, intestines and bladder inflamed.
4. "Lancet," May 15, 1841, p. 305 (Mr. Michael Foster). Female : æt. 2½. Dose (?).		
Symptoms.—Almost complete narcotism; intense inflammatory symptoms.	*Result.*—Death in 2 hours.	*Post-mortem.*—Stomach, intestines, and bladder inflamed; the appearances more intense than in the last case.
5. "Lancet," May 15, 1841, p. 305 (Mr. Michael Foster). æt. Five months. Dose (?).		
Symptoms.—Intense irritant symptoms.	*Result.*—Death in 6½ hours.	*Post-mortem.*—Inflammation very intense.
6. "Lancet," July 6, 1844, p. 507 (from "American Journal of Medical Science.") Male: adult. A lunatic! A teaspoonful.		
Symptoms.—Vomiting in half-an-hour; paralysis set in after some days, for which strychnia was administered, after which he entirely recovered, both from the poison and the lunacy!!!	*Result.* Recovery.	
7. "Lancet," 1836-37, vol. ii, p. 626 (Mr. Page). æt. 3½. 8 grains.		
Symptoms.—No symptoms set in for 4 days; death.	*Result.*—Death on 5th day.	
8. "Lancet," Nov. 4, 1848 (Mr. Fox). Male. A teaspoonful.		
Symptoms. No symptoms for 6 hours; when vomiting, purging, and drowsiness set in, but no pain, or tenderness of abdomen.	*Result.*—Death.	

9.

"Lancet," Oct. 2, 1852, p. 299 (Mr. Bryant). Male: æt. 30. ℥ij.

Symptoms.—No symptoms for 2 or 3 hours, and then not severe (emetics, stomach pump, and peroxide of iron used). The man was an habitual drunkard.	*Result.*—Recovery.	

10.

'Lancet," Nov. 2, 1844, p. 154 (Dr. Kelso). Female: æt. 8. Arsenic ʒj.—ʒij. mixed with oatmeal.

Symptoms.—Vomiting, pain, and heat in 1½ hours; in 4½ hours the symptoms much increased in severity (peroxide of iron given).	*Result.*—Recovery.	

11.

"Lancet," Nov. 30, 1844, p. 282 (Mr. Underhill). Male. 2 tablespoonfuls.

ymptoms.—Syncope; no sickness (peroxide of iron given.)	*Result.*—Recovery.	

12.

"Lancet," Nov. 30, 1844, p. 282 (Mr. Underhill). æt. 3. Arsenic with oatmeal.

ymptoms.—Ordinary symptoms (peroxide of iron given).	*Result.*—Recovery.	

13.

"Lancet," Nov. 30, 1844, p. 282 (Mr. Underhill). Female: æt. 31. 2 pennyworth.

mptoms.—Symptoms set in in half-an-hour; iron given.	*Result.*—Death.	

14.

"Lancet," Nov. 30, 1844, p. 282 (Mr. Underhill). 8 children ate cakes containing arsenic.

eroxide of iron given.)	*Result.*—All recovered.	

15.

Taylor's "Medical Jurisprudence," vol. i., p. 251. (Case of Lofthouse.)

ymptoms.—Symptoms set in whilst the cake which contained the poison was being eaten.	*Result.*—Death.	

16.

Taylor's "Medical Jurisprudence," vol. i., p. 251 (Mr. Todd's case). ʒj. on empty stomach.

mptoms.—Symptoms commenced in 2 hours.		

17.

Medical Times," Aug. 30, 1851, p. 229 (Mr. Jeffryes). Female: æt. 39. Arsenic taken in the solid form in a pudding, probably put in by mistake for egg powder.

mptoms.—Symptoms immediate; complete collapse in 2 hours; no vomiting or purging; death without any convulsions.	*Result.*—Death in 3 hours.	*Post-mortem.*—Post-mortem in 40 hrs.; stomach very inflamed especially at the pyloric end.

18.

ylor's "Medical Jurisprudence," vol. i., p. 256 (Mr. Thompson). Male: æt. 17. Large dose.

mptoms.—Symptoms of tetanus.	*Result.*—Death in 20 minutes.	

19.

Taylor's "Medical Jurisprudence," vol. i., p. 277. "Bradford Lozenge Case," Nov. 1858. "Medical Times and Gazette," Nov. 6, 1858, p. 476, and Dec. 25, 1858, p. 657. Arsenic used by mistake to adulterate lozenges instead of plaster of Paris.

Symptoms.—Over 200 persons attacked; 17 died—12 from acute poisoning and 5 from the secondary effects.	*Result.*—Deaths.	

20.

Taylor's "Medical Jurisprudence," vol. i., p. 253. Female: æt. 24. Large dose—over ʒj.

Symptoms.—Symptoms set in in 1 to 2 hours; they were not severe.	*Result.*—Death in about 2 hours.	*Post-mortem.*—Stomach internally inflamed; mucous membrane raised, and thickened, having broad, livid patches upon it.

21.

"Medical Times," Oct. 21, 1848, p. 26 (Mr. Clegg). Female: æt. 17. About a teaspoonful. (The girl was an opium eater, and this explains, no doubt, delay in symptoms.)

Symptoms.—Bad symptoms set in in 23 hours; she was sick once previously, but had no distress, no pain, vomiting, or diarrhœa; extreme narcotism.	*Result.*—Death in 23½ hours.	*Post-mortem.*—Mucous coat of stomach much corrugated, and both stomach and intestines inflamed; arsenic found.

22.

"Medical Times and Gazette," April 12, 1851, p. 413 (Dr. Ryan). Male. ʒss. taken in porter. He had been previously intoxicated for a week.

Symptoms — Symptoms commenced after 9 hours with vomiting; the patient slept during this time.	*Result.*—Death in 3 days.	

23.

"Flandin Toxicologie," vol. i., p. 510. Female. A small quantity taken in soup daily for six weeks.

Symptoms.—Vomiting after every meal, leading to great irritability of the stomach and general emaciation; nervous irritability; spitting of blood; the patient recovered when the cause was discovered.	*Result.*—Recovery.	

24.

"Lancet," January 2, 1847, p. 44 (Dr. Letheby). Female: æt. 19. 2½ grains taken in 2 ozs. of fly-water at night.

Symptoms.—Restless during the night; in the morning had pain, vomiting, and thirst; afterwards rallied, but coma eventually came on.	*Result.*—Death in 36 hours.	*Post-mortem.*—Brain congested; lungs natural; heart flabby, and valves ecchymosed; stomach pale, and nearly empty; pyloric end of a gamboge yellow tint.

25.

"Ann. d'Hyg.," 1852, vol. i., p. 418 (M. Chevallier).

		Post-mortem.—Stomach perforated at the larger end; aperture about an inch diameter, round, soft, and thickened at the margin; no redness about it, or appearance of ulceration on other parts.

26.

Taylor's "Medical Jurisprudence," vol. i., p. 254. Female: æt. 9. Arsenical ointment rubbed on scalp to kill vermin.

Symptoms.—No symptoms until the 5th day; on the 8th day cramp, diarrhœa, but no vomiting; drowsiness.	*Result.*—Death on the 10th day.	*Post-mortem.*—Stomach inflamed; arsenic found in the stomach and liver.

27.

"Taylor," vol. i., p. 255. [illegible] children. Arsenical vapours let into a room.

ymptoms.—All the children suffered; the infant, after being in the room for an hour, had pain, vomiting, and purging, and died; a canary died; the other children recovered.	*Result.*—Death in 24 hours.	*Post-mortem.*—Stomach and intestines inflamed; brain and lungs congested; lining membrane of trachea bright red.

28.

Taylor's "Medical Jurisprudence," vol. i., p. 268. Male: adult. Large dose.

ymptoms.—Symptoms set in very soon.	*Result.*—Death in 3 hours.	*Post-mortem.*—Intestines and stomach inflamed; arsenic found in the stomach, liver, and kidneys; the poison found as low down as the cæcum.

29.

aylor's "Medical Jurisprudence," vol. i., p. 269. "Atlee Family" (bodies exhumed after a month). "Lancet," Feb. 25, 1854. Female.

	Result.—Death after several days.	*Post-mortem.*—No arsenic found in the stomach or bowels, but *in the liver.*

30.

Edinburgh Monthly Medical Journal," Dec., 1857, p. 481 (Sir. R. Christison). Male. Arsenic given homicidally in whisky punch.

	Result.—Death in 5 to 7 hours.	*Post-mortem.*—90 to 100 grains was found in stomach.

31.

Lancet," April 12, 1845, p. 413 (Mr. Alison). Female: æt. 13. 2 teaspoonsful in 2 doses, with an hour's interval.

mptoms.—Violent pains in throat and stomach; (ferric oxyhydrate was administered, also magnesia and castor oil.)	*Result.*—Recovery.	

32.

Lancet," Feb. 1, 1845, p. 139. Male: æt. 21. Workman in candle factory where arsenic was used.

mptoms.—Some of the arsenic was absorbed through a wound.	*Result.*—Death in 3 days.	

33.

"Lancet," June 7, 1845, p. 640 (Mr. Woodcock). Female adult. Teaspoonful and a half.

mptoms.—Taken on an empty stomach; vomiting set in in 15 minutes, and continued for 48 hours; paralysis of the hands and feet. Recovered n 8 or 9 days.	*Result.*—Recovery.	

34.

"Lancet," Sep. 29, 1838, p. 54 (Dr. Murray). Male: æt. 22. 15 grains.

nptoms—Vomiting in 1 hour (hy-rated peroxide of iron adminis-ered).	*Result.*—Recovery.	

35.

Lancet," Oct. 6, 1838, p. 103 (Mr. Rayner). Female. Dose (?). Supposed to have been taken in treacle.

	Result.—Death.	*Post-mortem.*—The body was exhumed, and 2 or 3 drams of the sulphide found.

36.

"Lancet," Nov. 24, 1838, p. 324 (M. Deville). Female: æt. 19. 66 grs. mixed with 12·5 grs. of sulphate of baryta.

Symptoms.—In 1 hour vomiting, and heat in throat (four hours later the hydrated peroxide of iron was administered freely).	*Result.*—Recovery.	

37.

"Lancet," March 13 1841, p. 882 (Mr. Thompson). Male: æt. 18. Quantity?

Symptoms.—Cramps; no particular abdominal tenderness; death.	*Result.*—Death in 10 hours.	*Post-mortem.*—Stomach and intestines very inflamed; brain and lungs gorged with black blood.

38.

"Edinburgh Medical and Surgical Journal," xxxiii., p. 67 (Sir R. Christison). Three persons took 1 grain in wine.

Symptoms.—Serious symptoms for 12 hours.	*Result.*—Recovery.	

39.

"American Journal of Medical Science," vol. xi., p. 61. Male. 60 grains taken with cinchona bark powder.

	Result.—Recovery.	

40.

"Wibmer," vol. i., p. 278. Male. Took ʒiss after a very hearty meal.

Symptoms.—Vomited freely; and was well in 4 days.	*Result.*—Recovery.	

41.

"London Med. and Phys. Journal," xlvi., p. 467. Male. A quantity taken after a heavy supper.

Symptoms.—Severe symptoms.	*Result.*—Recovery.	

42.

"Medical Times and Gazette," April 18, 1857, p. 389 (Dr. Geoghegan). Male. Large dose.

	Result.—Death on 16th day.	*Post-mortem.*—No arsenic found on analysis.

43.

"Cours de Méd. Leg.," p. 121. Female: æt. 56. A solution used to cure the itch.

Symptoms.—Erysipelatous eruption induced; had great suffering; general tremor of limbs.	*Result.*—Death in 2 years.	

44.

"British Medical Journal," Jan. 25, 1873, p. 88 (Mr. Morley). 15 persons taken ill by eating a pudding in which a baking powder that was used contained arsenic.

Symptoms.—All had pain in the stomach and back; blood was vomited in one case; the conjunctivæ injected in all; in one case there was irritation of the skin.	*Result.*—Recovery.	

45.

"Medical Times," June 10, 1843, p. 169. 300 grains.

Symptoms.—As usual (emetics, and large doses of nitrate of potash in decoction of mallows administered).	*Result.*—Recovery.	

46.

"Medical Times," July 29, 1843, p. 288. Female: æt. 32. 120 grains.

Symptoms.—(Iron preparations given;) no intense symptoms set in for 3 days; death on the 6th day.	*Result.*—Death on 6th day.	

47.

"Lancet," March 29, 1862, p. 325 (Dr. Wilks). Male: æt. 36. ʒss of arsenic.

Symptoms.—Usual symptoms.	*Result.*—Death in 12 hours.	*Post-mortem.*—Blood fluid on both sides of the heart; mucous membrane of stomach intensely inflamed at the *pyloric* end; small intestines inflamed in patches; colon much contracted.

48.

"Lancet," June 18, 1864, p. 697 (Dr. Bingley), and June 25, 1864, p. 732 (Dr. Ellis). Female: æt. 40. Dose (?).

Symptoms.—Vomiting, and cramps in the legs; went to sleep, and was afterwards found dead.	*Result.*—Death.	*Post-mortem.*—Arsenic found.

49.

"Christison," p. 328 (Desgranges). Female. Arsenical ointment applied to head.

Symptoms.—Poisoning symptoms, including a papular eruption.	*Result.*—Recovery.	

50.

"Christison," p. 329 (Desgranges). Male: boy. Arsenic used as a face powder.

Symptoms.—Poisoning symptoms.	*Result.*—Recovery.	

51.

"American Journal of Medical Science," July, 1851, p. 259. Æt. 2. Arsenious acid and gum applied to the head.

Symptoms.—Purging; tenesmus; paralysis of the lower extremities.	*Result.*—Death in 36 hours.	

52.

"American Journal of Medical Science," July, 1858, p. 77 (Dr. W. C. Jackson). Male: æt. 28. ʒij on empty stomach.

Symptoms.—In 2 hours slight vomiting occurred, but the majority of the poison was not got rid of for 6 hours after it had been taken; then pain set in, which lasted for 6 hours.	*Result.*—Recovery.	

53.

"Christison," p. 308. Male. 1 oz.

Symptoms.—2 or 3 fits of vomiting, but very slight pain or heat in the stomach.	*Result.*—Death in 8 hours.	

54.

"Christison," p. 308. Female. Over ʒss.

Symptoms.—Very slight diarrhœa or pain; death preceded by convulsions.	*Result.*—Death.	*Post-mortem.*—Stomach and intestines healthy.

55.

"Christison," p. 308. Female: æt. 14. 90 grains.

ymptoms.—Vomited once or twice, but had very little pain.	*Result.*—Death in 5 hours.	*Post-mortem.*—Stomach and intestines healthy.

56.

"Christison," p. 308, "Revue Médicale," 1822. Male. Dose (?). The man was a drunkard.

Symptoms.—Perfectly tranquil for 5 hours, when he vomited, and a few minutes later expired.	*Result.*—Death in about 5 hours.	

57.

"Christison," p. 308 (Orfila). Male: adult. ʒiij.

Symptoms.—Walked about for some time; afterwards took an emetic, which produced free vomiting, but had no pain for 5 hours; died 4 hours after.	*Result.*—Death in 9 hours.	

58.

Orfila, "Toxicologie," vol. i., p. 397 (Prof. Chaussier). Male: adult. Large quantity.

Symptoms.—Intense feebleness, and tendency to faint; no other symptoms.	*Result.*—Death in a few hours.	*Post-mortem.*—No post-mortem appearances in stomach or intestines.

59.

"Journal de Médecine," lxx., p. 89 (M. Laborde). Female.

Symptoms.—Vomiting was induced by emetics; very little pain; coma came on, from which she died.	*Result.*—Death.	*Post-mortem.*—A clot of blood found in the stomach.

60.

"Christison," p. 310 (Dr. Choulant). Female. A thimbleful in soup.

Symptoms.—Vomiting, but no pain.	*Result.*—Death in 11 hours.	

61.

"London Medical Chirurgical Transactions," vol. ii., p. 134 (Dr. Roget). Female. ʒj.

Symptoms.—Violent symptoms for 24 hours; for the next 12 hours she improved; after which convulsions and nervous affections set in, which lasted for 17 days.	*Result.*—Recovery.	

62.

"Lancet," Jan. 16, 1849, p. 35 (Mr. Cornish). Male: adult. 1 oz. of arsenic mixed with flour and baked in a cake; taken on a full meal.

Symptoms.—Insensibility; vomiting; (stomach-pump used, and hydrated oxide of iron given;) recovered in 15 days.	*Result.*—Recovery.	

63.

"Lancet," Jan. 16, 1849, p. 35 (Mr. Cornish). Female: adult. 1 oz. of arsenic mixed with flour, and baked in a cake; taken on a full meal.

Symptoms.—Vomiting; pain.	*Result.*—Recovery.	

64.

"Lancet," July 7, 1849, p. 1 (Mr. Knott). Male. Arsenic (about ʒss) in brandy and water.

Symptoms.—Appeared for a short time to get better, but the bad symptoms returned; (hydrated peroxide of iron given.)	*Result.*—Death in 6 hours.	*Post-mortem.*—Gangrenous state of the lower half of the œsophagus; stomach along greater curvature and at pyloric end gangrenous; rest of the stomach uninjured.

65.

"Lancet," Sep. 22, 1849, p. 311 (Dr. McGee). Female: æt. 10. Rat poison (over 10 grains of arsenious acid).

Symptoms.—Emetics given before serious symptoms set in; chalybeates afterwards.	*Result.*—Recovery.	

66.

"Lancet," Aug. 22, 1846, p. 216 (Mr. Houghton). Female. ℥ss of arsenic.

Symptoms.—Great mental excitement set in in ¾ of an hour, but no vomiting, pain, or diarrhœa; vomiting set in afterwards; after which she felt disposed to dose; great depression followed; (stomach-pump used and hydrated oxide of iron given;) died in 12 hours; no gastric symptoms, or cramp, cerebral, or spinal symptoms occurred.	*Result.*—Death in 12 hours.	*Post-mortem.*—Bright red patch on the pyloric end of the stomach; mucous membrane not being in the least destroyed.

67.

"Lancet," Dec. 18, 1847, p. 651 (Dr. Barnes). Family consisting of male: adult. Female: adult. Male: æt. 9. Male: æt. 3. Male: æt. 1½. Female: æt. 4½. Female: æt. 6. Arsenic taken in rhubarb pudding.

Symptoms.—Symptoms as usual.	*Result.*—Two recovered; the rest died.	*Post-mortem.*—Inflammation in intestinal canal in all; stomach inflamed in 5 cases; duodenum inflamed in 5: jejunum in 5; ileum intensely inflamed in 1; colon in 5; rectum in 1; ecchymosed spot on the heart in 1; blood black, thin, and fluid in all; kidneys congested in 4; bladder empty in 4; liver congested in 2.

68.

"Lancet," Oct. 19, 1844, p. 103 (Mr. Argent). Female. ℥ss of arsenic after a meal.

Symptoms.—After 8 hours pain, vomiting and purging set in; (stomach pump used.)	*Result.*—Recovery.	

69.

"Medical Times and Gazette," Dec. 10, 1853, p. 612 (Dr. Mitchell). Male. Arsenical soap rubbed on scrotum and axillæ.

Symptoms.—Difficulty in swallowing after 12 hours; testicles became enlarged; vomiting, purging, and violent pain in stomach; recovery in a fortnight.	*Result.*—Recovery.	

70.

"Christison," p. 299 (Mr. Macaulay). ʒvii.

Symptoms.—Symptoms set in in 3 hrs.; the man slept between taking the poison and the commencement of the symptoms.	*Result.*—Death in 9 hours.	

71.

"Edinburgh Medical and Surgical Journal," lix., p. 350 (Dr. Dymock). Female. ℥ij.

Symptoms.—After 2½ hours got up from her bed, sat down on her chair, and died instantly.	*Result.*—Death in 2½ hours.	*Post-mortem.*—Stomach marked with scarlet patches.

72.

"Edinburgh Medical and Surgical Journal," xxxvi., p. 94. ¾oz. taken after a meal.

Symptoms.—No serious symptoms; free vomiting induced.	*Result.*—Recovery.	

(II.) ARSENITE OF POTASH.

73.

"Medical Times," Aug. 26, 1848, and "Provincial Journal," June 28, 1848, p. 347 (Dr. Castle). Female. ℥ss of liquor Fowleri taken in the course of 5 days = 3 grs. As_2O_3.

Symptoms.—No vomiting or purging; death *by syncope*.	*Result.*—Death on 5th day.	*Post-mortem.*—Stomach and intestines inflamed; heart flabby; arsenic found.

(III.) ARSENITE OF SODA.

74.

"Taylor on Poisons," p. 378. 340 children drank the water from out of a boiler that had previously been cleansed with arsenite of soda. Each took about 1 grain.

Symptoms.—Many suffered severely.	*Result.*—All recovered.	

75.

Taylor's "Medical Jurisprudence," vol. i., p. 273. Male. Drank beer from a pewter pot which had been cleansed with the arsenite.

Symptoms.—Acute symptoms.	*Result.*—Death.	

(IV.) ARSENITE OF COPPER.

76.

"Galtier," vol. i., p. 636. Male: æt. 3. Swallowed a capsule full of the arsenite, used by his father as a pigment.

Symptoms.—Symptoms of colic in half-an-hour, followed by acute symptoms; (hydrated oxide of iron administered).	*Result.*—Recovery in 24 hours.	

77.

"Galtier," vol. i., p. 636. Male: æt. 1. Several pieces of arsenite of copper cake eaten.

Symptoms.—Immediate vomiting; afterwards purging.	*Result.*—Recovery.	

78.

"Medical Times," April 28, 1849, p. 507 (Mr. Bully). Two children poisoned by confectionery coloured with the pigment.

Symptoms.—Symptoms severe.	*Result.*—Recovery.	

79.

"Lancet," March 5, 1859, p. 237 (Dr. Rose). Male: 9 months. Sucking green paint (Scheeles green).

Symptoms.—Very severe vomiting; purging; symptoms of collapse.	*Result.*—Recovery.	

80.

"Lancet," Dec. 1, 1860, p. 535 (Dr. Letheby). Male: æt. 3½. Arsenic from wall paper.

Symptoms.—Convulsions.	*Result.*—Death.	

81.

Taylor's "Medical Jurisprudence," vol. i., p. 274. 2 children. Coloured confectionery picked up in street = 2 to 3 grains.

Symptoms.—Symptoms as usual.	*Result.*—Death.	

82.

"Regina *v.* Franklin and Randall," "Taylor," p. 274, vol. i. Male. Given in blancmange.

	Result.—Death.	

83.

"Casper," page 73. Male: æt. 2½. Cake of green colour. Dose (?)

	Result.—Death in 5 hours.	

84.

"Lancet," Sept. 3, 1870, p. 356 (Dr. Hicks). Male: æt. 48. From a paper which he had been engaged in stripping off the walls.

Symptoms.—Violent symptoms; suppression of urine.	*Result.*—Recovery.	

85.

"British Medical Journal," Nov. 31, 1861, p. 598. Female: æt. 19. Artificial-flower maker.

Symptoms.—Greenish vomit; pains in stomach.	*Result.*—Death.	*Post-mortem.*—Arsenite of copper found in lungs, liver, and mesenteric glands; stomach highly congested.

(V.) ARSENATE OF POTASH AND SODA.

86.

"Beiträge zun Gerichtlichen Arznerkunde," vol. iv., p. 221 (Sir R. Christison, p. 284). A large quantity given by a druggist.

(VI.) SULPHIDES OF ARSENICUM.

87.

"Christison," p. 286, "Regina *v.* Burdock." Female. Orpiment containing 79 per cent. of white arsenic.

	Result.—Death.	

88.

"Medical Times," Oct. 17, 1847, p. 62 (Dr. Paterson). Female. ʒj of king's yellow.

Symptoms.—Vomiting in 2 to 4 hours; (hydrated peroxide of iron given;) patient died of chest affection on the 3rd day.	*Result.*—Death.	*Post-mortem.*—Lungs engorged; the stomach had patches of dirty green-coloured mucus adhering to its inner surface, but was not ulcerated or inflamed.

89.

Taylor's "Medical Jurisprudence," vol. i., p. 277, "Clifton Bath Bun Case," Dec., 1859. Orpiment used instead of chromate of lead to colour buns.

Symptoms.—Six persons suffered severely.	*Result.*—Recovery.	

90.

"Wharton and Stillé's Medical Jurisprudence," p. 434. Male: adult. Orpiment used instead of turmeric in porridge.

Symptoms.—Severe symptoms.	*Result.*—Death in 24 hours.	

91.

"Wharton and Stillé's Medical Jurisprudence," p. 434. Male: child. Orpiment used instead of turmeric in porridge.

Symptoms.—Severe symptoms.	*Result.*—Recovery.	

(VII.) CHLORIDE OF ARSENIC.

92.

Taylor's "Medical Jurisprudence," vol. i., p. 278. Female. M. xxx. in 23 hours ≑ 0·1 gr.

Symptoms.—Symptoms severe.	*Result.*—Recovery.	

(VIII.) ARSENIURETTED HYDROGEN.

93.

"Lyon Médicale," March 27, 1870 (Dr. Valette). Male: æt. 30. Breathed hydrogen containing arsenic from being prepared from impure zinc and acid.

Symptoms.—Vomiting and purging; bloody urine; (hydrated oxide of magnesia administered;) arsenic found in urine.	*Result.*—Recovery.	

94.

"Lyon Médicale," March 27, 1870 (Dr. Valette). Male. Breathed hydrogen made from impure zinc and acid.

Symptoms.—Similar symptoms to last case, but no urine passed for 24 hours; an eruption of papules occurred in this case.	*Result.*—Death on 13th day.	

95.

"Chemical News," Dec. 26, 1863. Male: æt. 22.

Symptoms.—Symptoms set in in 1 hour; all the symptoms of arsenical poisoning. There was an intermission of symptoms for 2 hours.	*Result.*—Death in 5 days.	

96.

"Dublin Journal of Medical Science," vol. xx., p. 422 (Dr. O'Reilly). Case of Mr. Brittain. Caused by preparing hydrogen with impure acid for breathing purposes (= to 12 grs. of arsenic).

Symptoms.—After second inhalation, seized with giddiness; passed 2ozs. of bloody urine and afterwards had pain and vomiting; no urine passed; jaundice.	*Result.*—Death on the 7th day.	*Post-mortem.*—Pleuræ contained 2 pints of red serum; lungs healthy; kidneys of an indigo blue colour; stomach inflamed in patches; bladder empty.

97.

Buchner's "Toxicologie," p. 476 (case of Geylen). Died whilst experimenting with the gas.

Symptoms.—No history on record.	*Result.*—Death.	

98.

"Repertorium fur die Pharmacie," vol. lxix., p. 271 (Dr. Schlinder). ½ cubic inch (a quantity corresponding to ⅛th of a grain of arsenic) inhaled in 40 minutes.

Symptoms.—Very severe symptoms; giddiness in 3 hours; pain; loss of muscular power; vomiting; great pain in kidneys, and constant desire to pass water, the urine being reddish-brown; recovered in 7 days; but after 3 weeks had a pustular eruption about the prepuce, which was not quite well for 7 weeks.	*Result.*—Recovery.	

Other Cases of Poisoning by Arsenious Acid, &c., are also recorded as follows:—

"Medical Times and Gazette," Sept. 13, 1851. p. 294. (Liquid fly poison. Death.)
" April 26, 1862, p. 416. } (Arsenical papers. Deaths.)
" May 3, 1862, p. 471. }
" July 19, 1862, p. 72. (Use of arsenical sheep-wash. Death.)
" April 11, 1857, p. 368. (Arsenic and antimony. Death.)
" Jan. 24, 1857, p. 62. (Arsenic taken to produce abortion.)
" April 25, 1857, p. 412. (Arsenic not found on analysis.)
"British Medical Journal," Jan. 17, 1874, p. 84. } (Deaths from Quack Pills, containing arsenic.)
" March 14, 1874, p. 355 }
"Medical Times and Gazette," Jan. 10, 1874, p. 52. (Arsenical papers.)
"Medical Times," Oct. 21, 1843, p. 39. (Inhalations insidiously inducing death. Golding Bird.)
" Oct. 25, 1845, p. 94 (Mr. Adams). (Several cases.)
" May 23, 1846, p. 162. (Norfolk cases of poisoning).
" April 10 and 17th, 1847, pp. 144 and 158. (Burton-on-Irwell cases.)
" June 5 and 12th, 1847, pp. 303 and 322. (Kensal New Town case.)
" Nov. 20, 1847, p. 107. (Sheridan's case.)
" Aug. 5, 1848, p. 221. (Bristol cases.)
"Medical Times and Gazette," vol. i., 1857, pp. 177 and 520. (Wall paper.)

"British Medical Journal," March 5, 1864, p. 276. (Death from arsenic applied to scalp.)
" Oct. 6, 1866, p. 395. (Death from ointment applied to ilium.)
"Lancet," Dec. 14, 1839, p. 451. (Case of Louis Mercier.)
"Taylor's Medical Jurisprudence," vol. ii., p. 251. (Symptoms set in in 8 minutes.)
"Annales d'Hygiène," 1837, vol. i., p. 344. (Symptoms set in in 7 hours.)
"Medical Chirurgical Review," Jan., 1854, p. 294. (Symptoms commenced in 5 or 6 hours.
"Flandin," vol. i., p. 535. (Arsenic found in stomach in a cyst of mucous membrane.)
"Medical Gazette," vol. xvi., p. 790. (Salivation occurred.)
"Orfila's Toxicologie," vol. i., p. 449. (Lockjaw in ¾ hour.)
"Medical Gazette," vol. xlvii., p. 181.
"Casper, N. S. S.," vol. ii., pp. 70, 71, 72.
"Medical Gazette," November 24, 1848.
"Pharmaceutical Journal," July, 1870, p. 60. (Arsenical wall papers.)
"Guy's Hospital Reports," Oct., 1850, p. 183.
"Taylor's Medical Jurisprudence," vol. i., p. 256 (death in two hours), and p. 268.
"Medical Gazette," xlviii., p. 446. (ʒss; no pain; death in 50 hours.)
"Annales d'Hygiène," 1847, vol. ii., p. 367. (Death on 6th day.)
"Lancet," July 11, 1863, p. 47. Queen *v.* Williams }
"Union Médicale," June 30, 1850 (Soufflard). } (No poison found after death.)
"Horn's Vierteljahrss," 1865, vol. i., p. 175. }
"London Medical Gazette," Aug. 16, 1850, pp. 46, 291. (Case of Ann Merritt.)
"Pharmaceutical Journal," July 27, 1872, p. 75. (Death very rapid.)
"Taylor's Medical Jurisprudence," vol. i., p. 271. (20 grains found in stomach 18 months after death.
Reg. *v.* Madeleine Smith, "Medical Times and Gazette," July 18, 1857, p. 66. (88 grains found.)
Reg. *v.* Dodds, "Taylor's Medical Jurisprudence," p. 71. (150 grains found.)
Reg. *v.* Hewitt (1863), "Taylor's Medical Jurisprudence," p. 271. (154 grains found.)
Reg. *v.* Holmes (1860), "Taylor's Medical Jurisprudence," p. 272. (Death in 7 days.)
Reg. *v.* Newton, "Lancet," Aug. 30, 1856, p. 262.
"Lancet," July 9, 1853, p. 41. (Arsenic found after 12 years' interment.)
" July 28, 1849, p. 99. (Arsenic found after 8 years' interment.)
"Taylor's Medical Jurisprudence," i., p. 271. (Arsenic found after 14 years' interment.)
"London Medical and Physiological Journal," xlix., p. 117. (Symptoms set in in 8 minutes.)
" " " xxviii., p. 347. (Death in 36 hours.)
"Edinburgh Medical and Surgical Journal," xiii., p. 507 (epileptic fits); xvii., p. 167. (Partial palsy.)
"Lancet," Nov. 3, 1866, p. 506. (Arsenic in the water used for making tea.)
"Guy's Hospital Reports," Oct., 1850, p. 218. }
"Medical Gazette," vol. xliii., p. 304. } (Arsenite of copper.
"Edinburgh Monthly Journal," July, 1851, p. 1. }
"London Medical Repository, January, 1819. }
"British Medical Journal," Aug. 30, 1873, p. 268. } Arsenate of potash and soda.

BISMUTH.

(Bi = 210 : sp. gr., 9·8 : fusing point, 264 C.)

Bismuth is generally found native. It is a hard, brittle, volatile, crystalline (rhombs) metal. It burns when heated in air. Nitric acid dissolves it freely. It is used in preparing "*fusible alloy*," a mixture very valuable to the die-sinker, from its property of expanding considerably as it cools:—

Bismuth Sesquioxide (yellow)	$Bi_2 O_3 = 468$.
Bismuth Peroxide (brown) .	$Bi_2 O_5 = 500$.
Bismuth Nitrate . . .	$Bi\,3(NO_3) + 5H_2 O = 396 + 90$.
Bismuth Chloride . .	$Bi\,Cl_3 = 316{\cdot}5$.
Bismuth Sulphide . .	$Bi_2 S_3 = 516$.

It is necessary that we should notice the

Bismuthic Nitrate $Bi\,3\,(NO_3) + 5\,H_2\,O$).

(Pearl White, Magistery of Bismuth.)

This is prepared by dissolving bismuth in nitric acid. If this solution be poured into water, the "trisnitrate," as it was formerly called, is thrown down. The "trisnitrate" is, in reality, a white, basic oxynitrate ($Bi\,(NO_4)\,H_2\,O$). It is largely used both medicinally, and as a face-paint, under the name of Pearl White. It is worth remembering by those that use it for the latter purpose, that a trace of sulphuretted hydrogen, such as may even be present in common gas, or be developed from boiled vegetables, will change its colour.

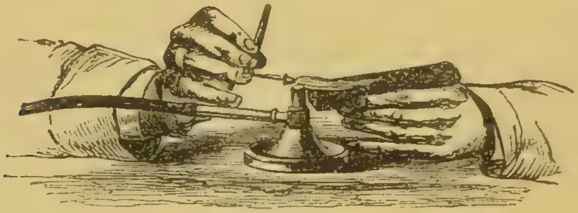
Orfila found that the soluble portion of fifteen grains of the *nitrate* injected into the jugular vein of a dog caused immediate staggering and death in eight minutes, whilst forty grains given internally, killed a dog in twenty-four hours. Of the *trisnitrate* two drams and a half killed a dog in twenty-four hours, the poison being found upon analysis in the liver, spleen, and urine. The stomach was in each case red, and ulcerated spots were apparent.

The nitrate is no doubt itself an irritant poison; but its frequent contamination with arsenic and carbonate of lead may account for many of the symptoms that have been described as occasioned by it. Dr. Taylor says that he found arsenic in three samples, purchased at respectable druggists, only two specimens in five being free from it. Well-described cases are on record, where violent salivation has taken place from the medicinal administration of five grains ("Lancet," Jan. 11, 1840, p. 584), and of seven grains of the nitrate ("Lancet," Jan. 25, 1840, p. 675).

Tests for Bismuth.

1. If bismuth compounds be heated on charcoal with carbonate of soda in the reducing blowpipe flame, a bright, brittle, metallic bead, having a yellow incrustation, is produced (fig. 20).

FIG. 20.



2. *Sulphuretted hydrogen* gives a black precipitate ($Bi_2 S_3$), insoluble in sulphide of ammonium, but soluble in hot mineral acids.

3. The *alkalies* give a white precipitate of the hydrated oxide ($Bi H_3 O_3$), insoluble in excess of the precipitant.

4. Solutions of bismuth, if not too acid, give a white precipitate when mixed with water. This precipitate is not soluble in tartaric acid, but is soluble in excess of nitric and hydrochloric acids.

5. *Chromate of potash* gives a yellow precipitate, soluble in dilute nitric acid.

6. *Iodide of potassium* gives a deep brown precipitate.

Cases of Poisoning by Nitrate of Bismuth.

1. "Christison," p. 495. Male: adult. ʒij. of trisnitrate.		
Symptoms.—Burning in throat; pain; purging; vomiting; cramps; suppression of urine; salivation on the fifth day; delirium on the sixth day.	*Result.*—Death on ninth day.	*Post-mortem.*—The whole alimentary tract gangrenous, but especially marked at the rectum; kidneys and brain healthy.
2. "Traill's Outlines," p. 115. (Taylor's "Medical Jurisprudence," p. 321.) Male: adult. ʒvi. of trisnitrate.		
Symptoms.—Vomiting; pain.	*Result.*—Recovery.	

CADMIUM.

(Cd = 112.)

Twenty grains of the oxide was found to induce vomiting in a dog, but that is all. In the form of iodide it is used as an outward application, having a similar therapeutic action to iodide of lead, without staining the skin. The sulphate is recommended as an anti-syphilitic.

CERIUM.

(Ce = 92.)

Cerium, given in doses of three drams of the chloride, produced no effect on a dog. The oxalate is used in medicine in one to two grain doses, as a local sedative and nervine tonic. It is said to be useful in the vomiting of pregnancy, and in dyspepsia generally. In nervous diseases, such as epilepsy and chorea, it has been found useful. Sir James Simpson was the first who suggested its use.

CHROMIUM.

(Cr = 52·5. Sp. gr. 6·8.)

Chromium is chiefly obtained from chrome iron stone ($Fe\,O\,Cr_2\,O_3$). It is a steel grey, hard and brittle metal, soluble in hydrochloric acid.

All the salts are coloured; and hence the name Chromium (*χρωμα*). All the chromium compounds are poisonous; it will, however, be sufficient to deal in detail with but one, viz., the dichromate of potash. The chromate of lead is yellow, and much used as a paint; but its poisonous action is principally due to the lead that it contains:—

Chromous Oxide (brown)	$Cr\,O$.
Chromic Oxide (green)	$Cr_2\,O_3$.
(Used as a paint; the colouring principle of the emerald and ruby.)	
An Oxide corresponding to the Magnetic Oxide of Iron	$Cr\,O\,Cr_2\,O_3$.
Chromic Acid	$Cr\,O_3$.
Chromate of Potash (yellow)	$K_2\,Cr\,O_4$.
Dichromate of Potash (red)	$K_2\,Cr\,O_4\,Cr\,O_3$.
Chromate of Lead	$Pb\,Cr\,O_4$.

Dichromate of Potash ($K_2 Cr O_4 Cr O_3$.)

This is a red transparent salt, crystallizing in four-sided tables, and soluble in about ten parts of cold water. It fuses below redness. It is not used by English physicians; but Burness and Mavor, on the continent, have advocated its use in secondary and tertiary syphilis, as well as in some hepatic cases. The dichromate, however, is largely employed by the dyer; and owing to its common use in this and other trade operations, it will be necessary to examine its action in some detail. It is commonly called *B*ichromate.

In acute poisoning it is found to act as a powerful irritant. There is usually constant and violent purging, the stools being of a peculiar clay colour, and painful vomiting of yellowish matters. The pupils are dilated. There are violent cramps in the legs, and the general depression produced is extreme. The urine is either suppressed, or in small quantity and purulent. The periosteum generally is swollen and painful. The action of the poison is specially marked on the mucous membranes. Two drams has caused death in four hours; but a case of recovery is recorded after a dose of two ounces.

The experiments of Gmelin on animals are important. One grain injected into the jugular vein of a dog had no apparent effect; four grains caused death in six days; ten grains caused instant death, by paralyzing the heart. Introduced under the skin, a dram caused death in six days, vomiting and palsy of the hind legs being the prominent symptoms. In one of the dogs an eruption appeared on the skin, and the hair fell off.

As regards the morbid anatomy, the effects are those of an irritant poison. The mucous membrane of the stomach will be found inflamed or destroyed, or marked with patches of dark red discoloration, the blood being black, and very thin. But its poisonous action (as is the case with most irritants) may be indirect, and entirely confined to the nervous system, and in such cases no well-marked post-mortem appearances may be observed.

The treatment must consist in the administration of emetics (if required), and the free use of carbonate of magnesia or lime, in milk.

Chronic Poisoning.

The effects produced on workmen engaged in the bichromate manufacture, a business of very considerable commercial importance, require consideration here.

From the researches of MM. Bécourt and Chevallier, we learn that no effect is produced on the health of the men engaged merely in the manufacture of the neutral chromate. But when the acid is added, at a boiling temperature, in order to convert the chromate into a bichromate, a number of fine particles are carried up, and are in this way dispersed throughout the workshop in which the operation is being conducted. The men usually become affected after they have worked for about a week, in the first instance complaining of a bitter nauseous taste in the mouth, of great irritation of the nasal mucous membrane, with incessant sneezing, of an increased secretion of tears, and even sometimes of severe conjunctivitis. If the work be continued, these symptoms increase, until at last the mucous membrane ulcerates, and even destruction of the septum nasi results. There is, however, one very common symptom observed, and that is chronic sores on the hands, shoulders, and feet. So long as the skin is sound, these do not form readily; but directly there is any lesion of the skin, the caustic action of the poison becomes apparent. One of the authors has noticed in a workman engaged in the bichromate business ulcers about the nose, mouth, feet, hands, and trunk, but particularly about the scrotum and penis, which, except from the man's history, and from the absence of any green colour about the ulcers (and which, however, is not constant), would have been difficult to diagnose from those found on workmen engaged in the manufacture of arsenical green colours. These sores go on to form large ulcers, with hardened edges. (*Vide*, "New Sydenham Soc. Year Book," 1859, p. 439; and 1863, p. 457.)

The sponging the throat with nitrate of silver solution, and the internal use of corrosive sublimate, constitute efficacious remedies.

Tests for Chromium and its Salts.

1. Heated in the borax bead, they impart to it a magnificent green colour.

2. Heated on platinum, with the blow-pipe flame, with nitre and sodium carbonate, a yellow mass ($KNa\ Cr\ O_4$) is formed, soluble in water, the solution giving a yellow precipitate ($Pb\ Cr\ O_4$), with acetate of lead.

3. No precipitate is produced with sulphuretted hydrogen.

4. *Sulphide of Ammonium* gives a green precipitate of the hydrated sesquioxide ($Cr_2\ O_3$, $3H_2\ O$).

5. *The fixed Alkalies* give a green precipitate ($Cr\ H_3\ O_3$), soluble in excess, but reprecipitated on boiling.

[NOTE.—In this way chromium, iron, and aluminium salts may be separated.
Ferric hydrate is insoluble in fixed alkalies, cold or hot.
Chromium hydrate is soluble in cold, but insoluble in hot.
Aluminium hydrate is soluble in both.]

6. *A Salt of Lead* gives a bright yellow precipitate ($Pb\ Cr\ O_4$).

Toxicological Analysis.

In a toxicological examination after poisoning by the dichromate, probably the red colour of the solution will materially guide us; but it may not unlikely be found to have assumed a greenish tint from the reduction of the chromic acid by the organic matter. The stomach and its contents, and other solid matters, should be well digested in water, acidulated with hydrochloric acid, boiled and filtered, and the filtrate tested.

Cases of Poisoning by Dichromate of Potash.

1.

"Christison," p. 496 (Dr. Schindler). Male: adult. Quantity (?)

Symptoms.—After vomiting had been induced, the patient seemed to recover, but became worse next day, with purging, pain in the kidneys, and retention. Extreme depression.	*Result.*—Death in 54 hours.	*Post-mortem.*—Stomach healthy; kidneys gorged with blood; bladder empty.

2.

"Medical Times," March 16 and 23, 1844, pp. 435, 456. Male: æt. 64. Quantity (?). Found dead in the morning.

Symptoms.—No signs that he had vomited or had been purged; gastritis not severe; narcotic symptoms chiefly.	*Result.*—Death in 12 hours.	*Post-mortem.*—Brain healthy; dilated pupils; no well-marked post-mortem appearances; the poison evidently killed by indirect action on the nervous system.

3.

"Guy's Hospital Reports," Oct. 1850, p. 216 (Mr. Bishop of Kirkstall). Male.

Symptoms.—Pain; vomiting; dilated pupils; cramps.	*Result.*—Recovery in 4 days.	

4.

"Horns Viertel Jahrsschrift," 1866, vol. ii., p. 113. Female: æt. 24. A dose taken to procure abortion.

Symptoms.—Pain; vomiting; purging.	*Result.*—Death.	

5.

Taylor's "Medical Jurisprudence," vol. i., p. 323 (Mr. Wood). Female: adult. ʒij.

Symptoms.—Vomiting and purging of yellowish matters. When first seen was apparently dying, pulseless, and unconscious.	*Result.*—Death in 4 hours.	*Post-mortem.*—Blood dark and liquid; mucous membrane of stomach dark brown, and destroyed in parts; part of small intestines much inflamed.

6.

"Lancet," Feb. 10, 1872, p. 210 (Dr. Andrews). Male: æt. 37. ℥ij. in solution.

Symptoms.—Cramp; vomiting; purging; dilated pupils.	*Result.*—Recovery in 9 hours.	

7.

"Lancet," Feb. 11, 1854, p. 152 (Mr. Heathcote). Male: æt. 30. Worked in a factory where bichromate was being crystallized.

Symptoms.—Sore throat, with ulcers; great exhaustion.	*Result.*—Recovery.	

COBALT.

(Co = 58·7. Sp. gr. 8·5.)

Cobalt is a reddish white metal, and when found (for it is rare), is always combined with either sulphur, arsenic, or nickel. It is used for the purpose of giving a blue colour to glass. *Smalt* is a powdered glass, coloured blue with oxide of cobalt; *Zaffre* is an impure oxide; *Rigman's Green* is a mixture of oxide of cobalt, with oxide of zinc. Given to dogs, thirty grains of the oxide proved fatal in a few hours; whilst three grains of the sulphate injected into a vein, proved fatal in four days.

Tests :—

1. *Sulphide of Ammonium* gives a black precipitate of sulphide of cobalt ($Co\ S$), which is insoluble in hydrochloric acid, but soluble in nitro-hydrochloric acid.

2. *Potash* gives a blue precipitate ($Co\ H_2\ O_2$), insoluble in excess.

3. *Ammonia* gives a blue precipitate, soluble in excess, and becoming a reddish brown liquid, the solution being aided by the addition of chloride of ammonium.

COPPER.

($Cu = 63{\cdot}5$. Sp. Gr. 8·95.)

Copper is found native; but it is, as a rule, obtained commercially either from copper pyrites ($Cu_2\ S, Fe_2\ S_3$), or from a green carbonate (Malachite, $Cu\ CO_3, Cu\ O, H_2\ O$), or from the blue carbonate ($2\ (Cu\ CO_3)\ Cu\ O, H_2\ O$).

Copper is found in sea-water and sea-weeds. Its presence in land-plants has been proved to depend on its existence in the manure used for the land on which they were grown.

Copper, as with many other metals, is said not to be poisonous in the metallic state. Halfpence are said to have been swallowed without ill results following, although even this is not always the case. ("Medical Times," Nov. 9, 1844, p. 119.) On the other hand, the breathing the finely-divided metal, such as the bronze dust used in painting, has proved very injurious, although this may be accounted for by the readiness with which the metal in such a state can become oxidized.

Copper is a red, very malleable, ductile metal, and when rubbed, gives out a peculiar coppery odour. It is a good conductor of heat and electricity. If heated in the presence of air, black scales of cupric oxide form upon it. If kept in moist air for any time, it becomes covered with the green carbonate (verdigris). Pure water has no action upon it. It is not soluble in cold sulphuric, or even in boiling hydrochloric acids; but it is soluble in hot sulphuric acid, fumes of sulphurous anhydride being given off. Nitric acid also dissolves it readily, red fumes of nitrous anhydride being evolved.

Copper is largely used in the manufacture of cooking utensils and for alloys, such as brass (2 of copper and 1 of zinc), bronze, bell-metal, German silver, &c. It is used for sheathing ships, whilst many of its salts are used in medicine, and in the arts as paints and pigments.

The salts of copper, like those of nickel and iron, are coloured, generally either blue or green, turning white when dried. They are all poisonous, except, perhaps, the sulphide. They are nearly all soluble in water, and in dilute acids.

The method of testing the copper foil, used in Reinsch's test, to prove its freedom from arsenic, is important; for a little copper is nearly always dissolved by the acid liquid, and commercial copper is rarely free from arsenic. Its purity may be tested as follows :—

(*a*) If clean copper strips be boiled with *pure* hydrochloric acid for some time, without any apparent tarnish, the copper may be considered pure.

(β) Place ten grains of the copper in a small glass retort, and heat with about twenty grains of precipitated peroxide of iron, and excess of hydrochloric acid. Distil to dryness into a little water. If any arsenic existed in the copper, it will be detected in the distillate, where it will be present as a chloride.

Cuprous Oxide, or Red Oxide	$Cu_2O = 143.$
Cupric Oxide, or Black Oxide	$CuO = 79{\cdot}5.$
Cupric Sulphate	$CuSO_4, 5H_2O = 159{\cdot}5 + 90.$
Cuprous Sulphide	$Cu_2S = 159.$
Cupric Sulphide	$CuS = 95{\cdot}5.$
Cupric Nitrate	$Cu\,2NO_3 + 6H_2O = 187{\cdot}5 + 108.$
Blue Copper Ore (*Hydrated Carbonate*)	$2(CuCO_3) + CuO, H_2O = 247 + 79{\cdot}5 + 18.$
Green Copper Ore, (*Malachite*)	$(CuCO_3) + CuO, H_2O = 123{\cdot}5 + 79{\cdot}5 + 18.$
Cuprous Chloride	$CuCl = 99.$
Cupric Chloride	$CuCl_2, 2H_2O = 134{\cdot}5 + 36.$
Cuprous Iodide	$CuI = 190{\cdot}5.$

Cuprous Oxide, or Red Oxide of Copper.

($Cu_2O = 143.$)

The red oxide is found native, or it may be formed artificially by warming a mixture of grape sugar, sulphate of copper, and potash solution, when a copious yellow, or red precipitate of the cuprous oxide (Cu_2O) will be formed.

Cupric Oxide, or Black Oxide of Copper.

($CuO = 79{\cdot}5.$)

The black oxide is formed either by heating copper in air, or by heating nitrate of copper in a crucible; or it may be precipitated as a hydrate, by adding potash to a solution of one of its salts.

Sulphate of Copper, or Cupric Sulphate.

($CuSO_4 + 5H_2O = 159{\cdot}5 + 90.$)

(Roman Vitriol, Blue Vitriol, Blue Stone, Blue Copperas, Vitriol of Copper.)

Sulphate of copper is usually found in the form of large blue crystals. It is soluble in four parts of cold, and in two of boiling water, the solution having an acid re-action. If blue vitriol be heated to 205° C., it loses its water of crystallization, and becomes colourless, in which state it is exceedingly hygroscopic. It is largely used in calico-printing. It will frequently be found to contain traces of arsenic, which it is important to remember if arsenic be found in the contents of the stomach, after the administration of sulphate of copper as an emetic.

Sulphide of Copper.

$(Cu\,S = 95{\cdot}5.)$

The sulphide is thrown down when sulphuretted hydrogen, or sulphide of ammonium is added to a solution of a copper salt.

Nitrate of Copper.

$(Cu\,2\,NO_3 + 6\,H_2\,O = 187{\cdot}5 + 108.)$

The nitrate is a blue deliquescent salt, and is much used in the manufacture of fireworks.

Carbonate of copper (*natural verdigris*) is formed on copper by the action of air and water. Malachite is also a carbonate.

The *acetates of copper* (*artificial verdigris*), which are the common copper pigments, differ much in composition, and contain variable proportions of the neutral acetate, and carbonate. They are only partially soluble in water, but are freely soluble in free acids.

Symptoms of Acute Poisoning. Dose, &c.

In full poisonous doses the copper salts produce the ordinary symptoms of irritant poisons. The patient complains immediately of the styptic coppery metallic taste of the poison, and of the burning heat in the throat. The vomiting of blue or green coloured matters is an early symptom. The vomit may possibly contain pieces of the copper salt. Much has been said about the possibility of confounding bilious vomiting with the vomiting of copper poisoning. If, however, a little ammonia be added to the vomit, no change will result if it be bile ; but if it be copper, a deep blue colour will be immediately produced. The patient within from fifteen minutes to half-an-hour will complain of severe headache, thirst, and dizziness. The pulse will be found small and irregular, and the body bathed in perspiration. Severe purging and tenesmus with intense colicky pains and troublesome eructations, complete or partial suppression of urine, spasms, and cramps of the extremities, are ordinary symptoms ; whilst in severe cases convulsions, tetanus, and complete insensibility may occur. Jaundice is, however, the specially diagnostic symptom of copper poisoning, and is nearly always present. It is never met with either in poisoning by arsenic, or by mercury.

It is stated that a purple line, of a somewhat permanent nature, may be seen round the gums a short time after the poison has been swallowed. A green line is seen in malachite workers.

Sulphate of copper was once deemed an active agent in producing abortion, and in the popular mind is still believed to have considerable power.

What quantity of copper will prove fatal? Death has been caused by one ounce of the sulphate. No doubt less than this, however, would poison, although recovery is recorded after an ounce, or even more. With the facts before us of such large doses producing in some cases no well-marked effects, it is strange when we read of bad symptoms resulting from the use of a brass injection apparatus, ("Lancet," Sept. 18, 1869,

p. 426), and from other causes, where the amount of copper present is almost homœopathic.

Death has occurred in as soon as four hours, whilst it has been delayed for three days.

Treatment.

If vomiting be not present, encourage it by draughts of warm water. The stomach-pump may be used, if necessary. Milk, mixed with sugar, and white of egg, should be given freely. The albumen produces an insoluble albuminate of copper, upon which the acid juices of the stomach have little or no action. (Orfila, Shrader, and Duval.)

Post-Mortem Appearances.

The body externally will usually be noticed to have a distinct yellow tinge. Upon opening the stomach and intestines, their contents will generally be found to be of a greenish blue colour; and upon touching them with ammonia, the tint will become greatly intensified. The lining membranes of the stomach and intestines are usually inflamed and thickened. In the stomach, the mucous membrane may be found softened, destroyed, or even ulcerated and gangrenous. In the small intestines perforations have been noticed, the escape of the contents setting up peritonitis. The rectum has been found ulcerated, and the lungs usually are congested.

Experiments upon Animals.

The experiments upon animals with copper salts demand notice, inasmuch as they prove that in whatever way copper may be introduced into the system, its action as a poison is violent. It acts not merely as an irritant poison when swallowed, but is equally energetic, when injected into the blood, paralysing the action of the heart, and in this manner causing death. Even its mere application to a wound has been fatal:—

Dose, &c.	How administered.	Symptoms.	Death.	Post-mortem.
12 grains of Verdigris (Drouard).	By the mouth (dog).		Death in 22 hours.	Stomach very little inflamed.
2 grains of Verdigris (Drouard).	Injected into jugular (dog).	Vomiting in seven minutes.	Death in 30 minutes.	No morbid appearances.
0·5 grains of Verdigris (Drouard).	ditto (dog).	On the 3rd day paralysis of the hind legs.	Death in 4 days.	
6 grains Sulphate of Copper (Drouard).	By the mouth (dog).		Death in 30 minutes.	No inflammation.
1 grain of Acetate of Copper (Orfila).	Injected into vein (dog.)	Convulsions.	Death in 10 minutes.	No post-mortem appearances.

Twelve to fifteen grains of the acetate the authors have found, usually proves fatal to dogs within one hour of its being administered, with convulsions and tetanus. Experiments prove that when the copper salts are given in large doses, they act as true irritant poisons. Their action, however, is far more energetic when they are introduced directly into the blood; and it is then that the other operation of the poison (for its action is double) is specially manifested; viz., its power "of exhausting muscular irritability, and occasioning death by paralysing the heart."

Chronic Copper Poisoning.

From the numerous uses to which copper is applied in every-day life, chronic poisoning by it is not very uncommon. Some of the causes that have produced it are as follows:—

From keeping orange-flowers and other distilled waters, and oils such as Cajeput oil, in copper vessels, or in vessels coloured with copper.

From its use in pickles, and in preserved fruits, to give them a green colour.

From its use in coloured confectionery. ("Medical Times," Sept. 14, 1844, p. 495; "Lancet," Feb. 17 and 24, 1849, pp. 191-216-219.)

From its presence in the water found in the neighbourhood of copper mines. (Existing as a sulphate from the gradual oxidation of the pyrites.)

From its presence in notable proportion in various mineral waters (with arsenic) (0·5 gr. per gallon), as in those of Schwalbach and Pyrmont (Walchner.)

From the use of a copper tea-kettle ("Medical Times and Gazette," Sept. 10, 1859, p. 265), and of copper vessels used for culinary purposes.

From the use of lemon-juice that has been kept in copper tanks. ("Medical Times and Gazette," June 20, 1868, p. 658.)

From the use of green wrappers for farinaceous foods. ("Medical Times," June 3, 1843, p. 158.)

From the use of inferior gold, such as is used by the cheap dentists for supports of artificial teeth, the action of the saliva producing soluble copper salts.

From the use of sulphate of copper as an adulterant of bread, which is added for the purpose of promoting the fermentation of the dough, to prevent loss, and to give it additional whiteness.

From the manufacture of artificial flowers, where copper salts are used as pigments. ("Medical Times and Gazette," June 20, 1868, p. 658.)

From the inhalation of anhydrous sulphate of copper, flying about workshops where it is used, in a state of minute subdivision. ("British Medical Journal," May 27, 1865, p. 543.)

From trades where copper has to be filed and handled, as *e.g.* coppersmiths ("Medical Times and Gazette," June 20, 1868, p. 658); watchmakers ("Medical Times and Gazette," Nov. 9, 1861, p. 488), &c.

From the external application of substances containing copper, such as the handling of arsenite of copper, a pigment largely used in the arts, &c. Workers in malachite also suffer.

M. Blandet states that in copper workshops, after fusing days, the men frequently suffer from various symptoms of poisoning, which end in a slightly feverish reaction. These last symptoms, however, M. Blandet attributes particularly to the zinc that is mixed with the copper to form bronze. It may further be noted here that copperworks have proved, owing either to careless work, or to want of proper appliances for condensation, a serious nuisance to the neighbourhood, from the escape of a white smoke ("copper smoke"), which contains arsenic, and which is very injurious both to animal and vegetable life.

Action of Water and Articles of Food on Copper.

In connection with chronic copper poisoning, it is important to note the results of the experiments of numerous investigators, amongst whom must be mentioned Falconer, Drouard, Eller, Orfila, and Christison, on the action of water, and of articles of food generally on copper. The facts may be thus summarised :—

1. Distilled water has no action upon clean copper, if air be excluded, even when kept in contact with it for weeks (Falconer and Drouard); but, on the contrary, if air be present, and the water be boiled in contact with the copper, then a certain quantity of copper is sure to be dissolved by the water.

2. Water containing a large amount of saline matter, and especially chlorides, nitrates, and sulphates, is more likely when boiled in contact with copper to dissolve the metal, than if the water be chemically pure.

3. Water, containing a quantity of common salt in solution, if boiled in copper pans, readily acts on the metal; but it is asserted that if at the same time fish or meat be boiled in the water, none of the copper will be dissolved. (Eller.—The truth of this is questioned by Orfila.)

4. Milk, tea, coffee, and beer, according to Eller,—and water, containing cabbages, potatoes, turnips, carrots, onions, rice, and barley, according to Falconer, have no action on copper vessels when boiled in them.

5. All acid solutions, such as vinegar, acid wines, &c.,—all matters containing acids, such as rhubarb, fruits, &c.—all fatty and oily matters, especially the volatile oils, and rancid oils, when boiled in copper or in brass vessels, and allowed to cool, are certain to dissolve some of the copper, a green colour being imparted to the food.

It is, however, well established :—

(α) That if an acid solution be boiled in a perfectly clean copper vessel, and poured out when hot (that is, not allowed to cool in contact with the copper), none of the metal will be dissolved.

(β) But that if the copper vessel be not perfectly clean, the mere boiling the acid solution will be sufficient to contaminate it.

(γ) That if the acid liquid be allowed to cool in contact with the copper, although the vessel be perfectly clean, some of the metal is certain to be dissolved. (Falconer and Proust.)

7. It has been suggested to line the copper vessels used in the kitchen with a mixture of lead and tin. This, however, soon wears off; and there is always a fear, when two metals are thus brought into contact, that galvanic action will be set up, and solution consequently aided thereby.

8. No copper vessels should be used for culinary purposes, as there is scarcely any article of food likely to be cooked in them that does not contain either an acid, or fatty matters of some kind. Cast iron is very preferable to copper.

9. Lastly, it may be worth noting that symptoms of *lead poisoning* may result from the tin that is used for tinning the vessels containing lead as an impurity; and *arsenical symptoms* from the copper similarly containing arsenic.

Symptoms of Chronic Poisoning.

In whatever way minute quantities of copper may be introduced into the system for a considerable period, chronic poisoning is likely to result. The premonitory symptoms are lassitude and giddiness, headache, a loss of appetite, constant thirst, and an ever-present metallic taste in the mouth. Extreme muscular debility, a constant desire to vomit, and diarrhœal motions of a dark colour, come on after a longer or shorter time; but acute colic and local paralysis are as rare in chronic copper poisoning, as they are common in chronic lead poisoning. Further, it is stated that copper-workers enjoy a peculiar immunity from cholera and choleraic diarrhœa. An early symptom that has been usually observed is a change in the colour of the skin (a kind of jaundice), accompanied by free perspirations of a bluish green colour which stain the shirt of the patient. Dr. Perron has noticed a green or bronzed stain on the teeth of watchmakers and others engaged in filing the metal ("Medical Times and Gazette," Nov. 9, 1861, p. 488); and Dr. Clapton likewise records similar stains in copper-workers generally, as well as a green line around the margin of the gums due, he considers, to the actual absorption of the poison. ("Lancet," Oct. 16, 1869, p. 543.) Other observers, however, have not noticed this line even in well-marked cases of copper poisoning. Sir D. Corrigan states that in nearly all cases, he has noticed a peculiarly characteristic retraction of the gums, the edges of which appear of a purple colour. ("Dublin Hospital Gazette," Sept., 1855.) The hair is said sometimes to turn of a green tint; and not unfrequently a vesicular eruption has been noticed about the roots of the hairs on the pubes.

The treatment will be suggested by the symptoms. One thing is certain, that all treatment will fail unless the cause of the mischief be abandoned. Milk is said to be a prophylactic; and Dr. Perron advises that those engaged in filing copper should wear moustachios. ("Medical Times and Gazette," Nov. 9, 1861, p. 488.)

Tests.

1. *Sulphuretted Hydrogen* gives even with acid solutions of copper, or its salts, a brown black precipitate, which turns a greenish black when dried. It is insoluble in caustic alkalies, but is soluble in hot concentrated hydrochloric acid, and in dilute nitric acid, when a blue solution results. By exposure to moist air, the sulphide becomes sulphate.

To test the Precipitate :—

Dissolve by heat in dilute nitric acid. Evaporate to dryness, dissolve the residue in water, and test for copper with ammonia, with ferrocyanide of potassium, &c.

(Note.—Neither nickel, chromium, uranium, nor cobalt are precipitated by H_2S in acid, or neutral solutions.)

2. *Ammonia* gives—

(*a*) With *strong copper solutions*, a bluish white amorphous precipitate. This is soluble in excess of ammonia, when a deep purple blue liquid is formed ($Cu\,O, 2\,NH_3$.)

(*β*) With *dilute copper solutions* no precipitate is formed, but the liquid turns of a deep blue colour.

Caustic Potash has no action on the blue solution, even when added in great excess; but *free acids*, added in excess, destroy the colour. The colourless liquid thus produced, after the acid is added, may then be further tested for copper, with potassic ferrocyanide.

(Note.—With *Nickel*, ammonia gives *a green precipitate*, soluble in excess, the solution being *blue*, and reprecipitated on the addition of caustic potash.

With *Chromium*, ammonia gives *a grayish-blue precipitate*, soluble in excess, the solution being *pink*.

With *Uranium*, ammonia gives *a yellow precipitate*, insoluble in excess.

With *Cobalt*, ammonia gives *a blue precipitate*, soluble in excess, the solution being *reddish-brown*.)

3. *Ferrocyanide of Potassium* gives—

(*a*) In *strong solutions* of copper salts, a reddish-brown gelatinous precipitate of ferrocyanide of copper.

(*β*) But in *dilute solutions* the liquid merely turns of a rich claret colour.

The precipitate is sparingly soluble in ammonia, and is insoluble in the mineral acids, in acetic acid, or in excess of the precipitant.

(Note.—Uranium also gives a brown precipitate, with ferrocyanide of potassium.)

4. *Iron Test.* Immerse a piece of bright iron or steel (a large darning-needle answers the purpose very well) in a solution of a copper salt, when the iron gradually acquires a coating of metallic copper. Some of the iron dissolves, and forms a salt with the acid previously combined with the copper.

$$Fe + Cu\,SO_4 = Fe\,SO_4 + Cu.$$

If there was enough copper in the solution, all the iron would in time be dissolved, and a hollow copper cylinder left. In dilute copper solutions the deposition is much facilitated by the addition of either a little hydrochloric or sulphuric acids.

To further test the deposit on the needle, it must be removed, and the copper coating well washed with water. It may then be acted upon with a little ammonia, which, by exposure to air, will dissolve it, a deep blue solution being formed. Acidify this with acetic acid and test the colourless solution for copper with ferrocyanide of potassium.

Orfila suggested the use of phosphorus instead of iron or steel, but it is not nearly so manageable.

5. *Galvanic Test.* Acidulate the copper solution with hydrochloric acid, and place it in a platinum-dish. A piece of bright zinc is then to be put into the solution, when the copper will be deposited on the platinum as a brown stain, wherever the zinc touches it.

A little ammonia, with exposure to air, will dissolve the stain thus formed, the solution becoming blue, which may then be further tested by first decolorizing with acetic acid, and then adding ferrocyanide of potassium.

6. *Blow-pipe Test.* Salts of copper mixed with carbonate of soda, and heated on charcoal in the reducing blow-pipe flame, yield globules of metallic copper, which are of a red colour and very malleable. These may be dissolved in nitric acid and tested accordingly.

7. *Colour Tests.* Salts of copper heated in the inner blow-pipe flame, impart a brilliant green colour to the outer flame.

We must note several other reactions of copper, none of which however are of much importance.

1. *The fixed Caustic Alkalies* give a blue amorphous precipitate of the hydrated oxide ($Cu\,O, H_2\,O$), insoluble in excess of the precipitate, and turning black when boiled.

And here, it is to be noted, that if some bodies, such as grape-sugar, be present, the copper is soluble in excess, forming under these circumstances a deep blue solution, from which the copper is thrown down as a yellow suboxide ($Cu_2\,O$) by boiling.

2. *The soluble Carbonates* give a greenish-blue amorphous precipitate of the hydrated oxycarbonates, soluble in excess.

3. *Arsenite of Potash* gives in neutral solutions a bright green precipitate of arsenite of copper (Scheele's green), soluble in ammonia and in free acids.

4. *Chromate of Potash* gives with strong solutions a reddish-brown precipitate, and with dilute solutions a greenish-yellow precipitate, soluble in ammonia.

5. *Ferricyanide of Potassium* gives a brownish-yellow amorphous precipitate, soluble in ammonia and insoluble in acetic acid.

6. *Iodide of Potassium* gives a brownish-green precipitate, soluble in ammonia.

Quantitative Analysis.

The quantitative estimation of copper may be effected by weighing it as an oxide.

(*a*) Heat the solution to boiling and precipitate with caustic potash. Cool the liquid and collect the precipitate on a filter; wash, dry, ignite, and weigh. If the filtrate still has a blue colour, proving that more copper is present, boil with grape-sugar, and throw the copper down as $Cu_2\,O$, which must then be collected, washed, moistened with nitric acid, evaporated to dryness, and the residue obtained ignited, and added to the precipitate formed with the caustic potash :—

100 grains of $Cu\,O = 314{\cdot}21$ of $Cu\,SO_4 + 5\,H_2\,O$.
" " $= 371{\cdot}43$ of $Cu\,2\,NO_3 + 6H_2\,O$.
" " $= 120{\cdot}25$ of $Cu\,S$.

(β) Or the precipitated sulphide may be dried and weighed:—

100 grains of $Cu\,S = 261{\cdot}1$ of $Cu\,SO_4 + 5\,H_2\,O$.
" " $= 309{\cdot}52$ of $Cu\,2\,NO_3 + 6\,H_2O$.
" " $= 82{\cdot}15$ of $Cu\,O$.

Toxicological Analysis.

Previously to describing the process to be adopted in toxicological investigations, it is important to note that some observers, and particularly Sarzeau, have asserted that copper is a normal constituent of both plants and animals, and is always to be found in the blood, as well as in coffee, wheat, cinchona bark, &c. These views were held by others besides Sarzeau, as by Orfila, Henry, Devergie, and Meissner, but were opposed by Flandin and Danger, Chevreul, Christison, &c.

Boutigny, who has investigated the subject with great care, asserts that copper is never found in flour, wine, or cyder, unless it is present in the manure used in raising the wheat, grapes, or apples. He asserts that the street manure from towns nearly always contains a trace of copper; and he concludes, that if copper be present in the animal body, it is not as a normal constituent, but is introduced either by the use of copper vessels in cooking, or by vegetables that have been fed with a manure containing it. Fortunately the amount found has never exceeded the 1-120,000th part, whilst it is often as little as the 1-500,000th. It is scarcely likely, therefore, to be a fallacy.

It may be well to note, moreover, that copper has been found by M. Hiers Reynaert in the ash of filter-papers.

In conducting a medico-legal examination, it must be remembered that copper may be present in the stomach both in an insoluble as well as in a soluble form, inasmuch as certain organic principles, such as albumen and the mucous membrane of the stomach itself, will throw down an oxide of the metal. As a rule, however, all the forms in which it will be found are soluble in acids. In examining the contents of the stomach, it is advisable to scrape it thoroughly, in order to remove the insoluble portions adhering to the mucous membrane. Organic liquids containing copper are generally of a greenish blue colour.

Proceed as follows:—

(1) Dilute the contents of the stomach with sufficient water, that they may filter easily. Acidulate with hydrochloric acid, and after allowing them to stand for some hours and shaking frequently, filter.

Pass sulphuretted hydrogen through the clear filtrate, and throw down the copper as a sulphide. Collect the precipitate on a filter-paper, and dissolve in dilute nitric acid, when a sulphate of copper will be formed. Evaporate the solution to dryness, dissolve the residue in water, and test as already directed.

If you have a large quantity of the copper solution, it is well to test a portion by placing a clean needle in the liquid and allowing it to remain in for some hours. The deposit must be examined as already directed. It must not be concluded that a mere reddish deposit on the needle, without further analysis, is copper, as it is often difficult to distinguish this by the naked-eye appearance from a deposit due to the formation of a little oxide of iron.

(2) (*a*) Cut the solid matters up into small pieces, and bruise them in a mortar. Boil for a short time in dilute hydrochloric acid, filter, concentrate the filtrate, and test with sulphuretted hydrogen.

(β) All the solid matters that are left should now be incinerated, when if copper be present, the ash will be of a bluish colour. (It does not, however, follow that a blue ash is due to copper.) Dissolve this in dilute nitric acid (one to one of water), filter, and test with sulphuretted hydrogen.

Cases of Poisoning with Copper.

(I.) SULPHATE OF COPPER.

1.
"La France Médicale," Sept. 16, 1874 (case of Moreau). Recorded in detail in the "British Medical Journal," Sept. 26, 1874. Female: æt. 33.

Symptoms.—Cramps; a quantity of glairy mucus vomited; great pains in the stomach; gradual exhaustion.	*Result.*—Death.	*Post-mortem.*—Copper found.

2.
"Medical Gazette," vol. xviii., p. 742. Female: æt. 16 months. Put pieces in mouth, and sucked them.

Symptoms.—Vomiting in 15 minutes; no convulsions.	*Result.*—Death in 4 hours.	

3.
Beck's "Medical Jurisprudence," vol. ii., p. 667. Male: æt. 40. ʒj.

	Result.—Death in 12 hours.	

4.
"Wormley," p. 377 (Dr. Percival). Female: adult. ʒij.

Symptoms.—Violent symptoms.	*Result.*—Recovery.	

5.
Stillé, "Materia Medica," vol. i., p. 325. ʒj.

	Result.—Recovery.	

6.
"Lancet," April 30, 1842, p. 145 (Dr. R. B. Todd). Female: æt. 18. A quantity in solution.

Symptoms.—Violent irritant symptoms, continuing for 9 days; no jaundice.	*Result.*—Recovery.	

7.
"Medical Times," Jan. 9, 1847, p. 284. Female: æt. 36. 310 grains.

Symptoms.—Immediate pains in throat and stomach, with sickness.	*Result.*—Recovery.	

8.
Wein. "Med. Wochensch.," 1871. No. 26. Sulphate of copper.

Symptoms.—Jaundice.	*Result.*—Death in 3 days.	*Post-mortem.*—Fatty degeneration of liver.

9.
"Medical Times and Gazette," Oct. 20, 1866, p. 435. Female: æt. 75. Sulphate of copper.

(II.) VERDIGRIS.

10.

"Taschenbuch," p. 458 (Niemann), quoted by Taylor, p. 304. Female: æt. 24. ℥ss.

Symptoms.—Irritation of stomach.	*Result.*—Death in 60 hours.	

11.

"Wormley," p. 376 (Pyl); "Christison," p. 466. Female. ʒij.

Symptoms.—Convulsions; paralysis.	*Result.*—Death in 3 days.	

12.

Orfila, "Toxicologie," vol. i., p. 519. Male: adult. ℥ss in water.

Symptoms.—Symptoms set in after 15 minutes: violent vomiting and jaundice; also purging.	*Result.*—Recovery on fourth day.	

(III.) CHRONIC POISONING.

13.

Taylor's "Medical Jurisprudence," vol. i., p. 306.—A lady and some children ate some rhubarb stewed in a copper vessel imperfectly tinned. All were taken ill, and the lady died after severe symptoms, from which she partially recovered, but which afterwards came on with increased severity.

14.

"Guy's Hospital Reports," 1866, p. 329. Symptoms of poisoning induced in a family by the use of a badly-tinned copper vessel for cooking. One old man (æt. 90) died in three weeks.

15.

"Pharmaceutical Journal," August, 1870, p. 158. Ten persons taken ill (in Geneva) from food being cooked in a dirty copper vessel.

16.

"Wormley," p. 376 (Dr. Percival). Female: æt. 17. From eating pickled samphire contaminated with copper.

Symptoms.—No nervous symptoms. No convulsions.	*Result.*—Death on ninth day.	

17.

"Christison," p. 466. 2 Females: lady and daughter. From eating saurkraut kept in copper.

	Result.—One died in 12 hours, the other in 13.	*Post-mortem.*—Skin very yellow after death.

18.

"Christison," p. 454. Gmelin traced an outbreak of illness at a monastery from the use of copper vessels. A similar case also recorded at the Monastery of the Jacobin monks at Paris.

19.

"Christison," p. 467. Female: æt. 18. From beans cooked in copper vessel.

Symptoms.—Sickness at first; afterwards convulsions and insensibility.	*Result.*—Death in 78 hours.	

20.

"Lancet," Aug. 1, 1863, p. 129 (Dr. Harley). Male: æt. 18. Copper-plate worker.

Symptoms.—Acute abdominal pains; purple line round the gums, the line remaining for some time after recovery.	*Result.*—Recovery.	

For other Cases of Copper Poisoning, see—

"Pharmaceutical Journal," 1870, p. 874. (Sulphate of copper.)
"Medical Times," April 11, 1846, p. 33, and Nov. 25, 1843. (Verdigris.)
"Medical Times and Gazette," June, 1868, p. 658, and 1870, vol. i., p. 581. (Chronic poisoning.)

GOLD ($Au = 196{\cdot}5.$)

Gold is a soft yellow metal, and has been employed from time to time as a medicine, chiefly in the treatment of scrofulous and venereal affections. It is used by dentists for stopping teeth. The perchloride ($Au\ Cl_3$) is the only compound we need notice; but although a violent poison, we have no cases of poisoning to record with it in the human subject. Orfila found that very small quantities would kill animals in a few minutes if injected into the veins. Its action is corrosive, death resulting purely from local injury, and not as the result of the absorption of the poison. In the form of *fulminate*, in which it was formerly prescribed, six grains have proved fatal, vomiting, convulsions, and salivation being prominent symptoms.

Tests.

1. *Sulphuretted Hydrogen* gives a brown precipitate ($Au_2\ S_3$), soluble in sulphide of ammonium.
2. *Ferrous Sulphate* gives a *brown* precipitate of metallic gold.
3. *Proto-chloride of Tin* gives a purple precipitate (purple of cassius).

IRIDIUM ($Ir = 197.$) RHODIUM ($Ro = 104.$)

Iridium and rhodium are white, hard, brittle metals. The salts of rhodium are rose-coloured. The metals are very difficult of solution, even in nitro-muriatic acid. Both are found in platinum ores.

The chlorides of both metals are poisonous, and act similarly to platinum, but not, perhaps, quite so energetically.

IRON ($Fe = 56.$ Sp. Gr. 7·84.)

Iron is found native in meteoric stones, and but seldom under other circumstances.

The ores are numerous.

It is soluble in dilute sulphuric and hydrochloric acids, and also in a weak solution of nitric acid.

Dry air does not affect it, but it oxidizes rapidly, if moisture be present. Iron itself is not a poison; and only two of the salts need further description (viz., the sulphate and the chloride) as possessing interest to the toxicologist.

Ferrous Sulphate, or Sulphate of Iron ($Fe.\ SO_4,\ 7\ H_2O$), *Green Vitriol, Copperas.*

This is prepared by dissolving iron wire in sulphuric acid.

It is insoluble in alcohol, but is soluble in one-and-a-half times its weight of cold water. It has a powerful astringent action; and for this, and as a hæmatinic and an emmenagogue, it is largely used in medicine. It is also largely used in ink and dye manufactures.

Ferric Chloride ($Fe_2 Cl_6$).
(Liquor Ferri Perchloridi.)

The solution is prepared by dissolving iron wire in hydrochloric acid, and peroxidizing the iron by boiling with nitric acid. The application of the perchloride to prevent hæmorrhage, a use to which it is frequently applied, has been known to produce injurious effects. ("Lancet," Mar. 16, 1861, p. 279.) Its injection into a nævus has proved fatal.

The iron salts, none of which are active poisons, have been taken and administered on several occasions for the purpose of procuring criminal abortion. The symptoms that are usually induced by an overdose are those of an irritant poison, with pain in the stomach, vomiting of an inky fluid, and violent purging. Its administration to pregnant females formed a subject of discussion before the Obstetrical Society, to which discussion the reader is referred. ("Trans. Obstet. Soc.," vol. xii. p. 33.)

The treatment must consist in the use of the stomach-pump, emetics if necessary, and diluents with alkaline carbonates.

Gmelin found that when two drams of the sulphate was administered to dogs, no symptom other than vomiting was produced. Twenty grains injected into the veins of dogs produced no effect whatsoever. Rabbits, moreover, swallowed forty grains without injury. There is, however, some discrepancy between these results and those obtained by Dr. Smith, who found that dogs died in twenty-four hours after a dose of two drams, but that much less proved fatal when applied to a wound.

The post-mortem appearances are those of a pure irritant. The stomach and bowels will probably be found to contain a quantity of black fluid throughout their whole length.

Tests for Iron and its Salts.

Note, *Sulphuretted Hydrogen* gives no precipitate with a solution of a *Ferrous Salt* acidulated with hydrochloric acid; but with a solution of a *Ferric Salt* a white precipitate of sulphur is thrown down, whilst the ferric becomes a ferrous salt.

$$2\ Fe_2\ Cl_6 + 2\ H_2\ S = 4\ Fe\ Cl_2 + 4\ H\ Cl + S_2.$$

With *Sulphide of Ammonium* a solution of a *Ferrous* salt gives a black precipitate of ferrous sulphide ($Fe\ S$). If added to a *Ferric* solution, the ferric salt is reduced to a ferrous salt, the black $Fe\ S$ being precipitated, and sulphur set free.

1. *Ferrous Salts* (that is, salts having $Fe\ O$ as the base) represented by green vitriol ($Fe\ S\ O_4$) have the following properties and reactions:—

   1. They are generally colourless, or of a light green tint when in solution, and have an inky taste.
   2. *The Alkalies* give a greenish precipitate of ferrous hydrate ($Fe\ H_2\ O_2$), which becomes red when exposed to air.
   3. *Ferrocyanide of Potassium* gives a pale blue precipitate (ferrocyanide of iron and potassium, $K_2\ Fe_2\ Cy_6$).
   4. *Ferricyanide of Potassium* gives a dark blue precipitate ($Fe_5\ Cy_{12}$), insoluble in dilute acids.

5. *Soluble Carbonates* give a precipitate of iron carbonate, which is white when pure.
6. A soluble ferrous salt boiled with nitric acid becomes converted into a ferric salt, one of the lower oxides of nitrogen escaping.

2. *Ferric Salts* (that is, salts having Fe_2O_3 as the base, as represented by sesquichloride of iron, Fe_2Cl_6) have the following properties and reactions.

1. The solutions are usually yellow, red, or brown.
2. The alkalies (and their carbonates) give a red precipitate of ferric hydrate ($Fe_2H_6O_6$), insoluble even when boiled.
3. *Ferrocyanide of Potassium* gives a deep blue precipitate of sesquiferrocyanide of iron (Fe_7Cy_{18}), insoluble in dilute acids, but decomposed by alkalies.
4. *Sulphocyanide of Potassium* produces a deep red solution (ferric sulphocyanide, $Fe_2Cy_6S_6$).
5. *Tincture of Galls* produces a black (inky) solution.
6. *Ferricyanide of Potassium* produces no precipitate. It is therefore the distinguishing test between ferrous and ferric salts.

Iron salts are soluble in a borax bead, giving it a bottle-green colour in the reducing, and a brownish tint in the oxidising flame.

Toxicological Analysis.

In examining organic matters for iron, digest them thoroughly with water acidulated with acetic acid; filter; evaporate the filtrate to dryness; incinerate the residue, and after acting on the ash with dilute sulphuric acid, test accordingly with sulphuretted hydrogen, ferrocyanide of potassium, &c.

To estimate Iron quantitatively, oxidize it first to the condition of a peroxide with nitric acid and heat, and then precipitate with ammonia. Collect the precipitate and dry. Every 80 parts is equal to 56 of iron. Permanganate of Potash may be used for the same purpose.

Cases of Poisoning with Iron.

<table>
<tr><th colspan="3">TINCTURE OF PERCHLORIDE OF IRON.</th></tr>
<tr><td colspan="3">1.
Taylor's "Medical Jurisprudence," vol. i., p. 320. Female: æt. 15. ℥j to induce abortion.</td></tr>
<tr><td>Symptoms.—Great irritation of urinary system.</td><td>Result.—Recovery.</td><td></td></tr>
<tr><td colspan="3">2.
"Provincial Journal," April 7, 1847 (Mr. Aymot). Female: adult. ℥iss of the tincture.</td></tr>
<tr><td>Symptoms. — Immediate vomiting; cough; pain along gullet and in stomach; black motions.</td><td>Result.—Recovery in a month.</td><td></td></tr>
<tr><td colspan="3">3.
"Dublin Medical Press," Feb. 21, 1849 (Sir James Murray). Male: æt. 72. ℥iij.</td></tr>
<tr><td>Symptoms.—Symptoms of suffocation; tongue very swollen; pulse feeble; motions black.</td><td>Result.—Recovery.</td><td></td></tr>
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<tr><td colspan="3">4.
"Pharmaceutical Journal," April, 1869, p. 605. ℥j.</td></tr>
<tr><td></td><td>Result.—Recovery.</td><td></td></tr>
<tr><td colspan="3">5.
"Lancet," Jan. 2, 1869, p. 9 (Mr. Warburton). Female: æt. 30. ℥j.</td></tr>
<tr><td>Symptoms.—Severe convulsions in ¼ of an hour; vomiting was produced by emetics, and in 5½ hours the patient was fairly well.</td><td>Result —Recovery.</td><td></td></tr>
<tr><td colspan="3">6.
"American Journal of Medical Science," April, 1870, p. 506. Used as a uterine injection.</td></tr>
<tr><td>Symptoms.—Peritonitis.</td><td>Result.—Death.</td><td></td></tr>
<tr><td colspan="3">7.
"Christison," p. 506 (Dr. Combe). Male: adult. ℥iss.</td></tr>
<tr><td>Symptoms.—Inky and bloody vomiting; bloody purging. Seemed to recover in three weeks, but had a relapse two weeks afterwards.</td><td>Result.—Death in six weeks.</td><td>Post-mortem.—Pylorus thickened; extensive inflammation.</td></tr>
<tr><td colspan="3">8.
Lancet," Feb. 7, 1874, p. 195 (Mr. W. B. Kesteven). Æt. 9 months. A nævus on the head injected with about 3 minims of the perchloride. The same operation had been performed on the child six months previously.</td></tr>
<tr><td>Symptoms.—Convulsions.</td><td>Result.—Death in 5 minutes.</td><td></td></tr>
</table>

For Cases of Poisoning with the Sulphate, see

"Medical Gazette," 1850, p. 640; "Ann. d'Hyg.," 1851, vol. i., p. 155; Christison, p. 506 (Recovery after ℥j).

LEAD.

(Pb = 207. Sp. gr. 11·4. Melts at 327° Cent.).

Lead is usually prepared from galæna ($Pb\,S$), by first heating it in air, by which means a mixture is produced of oxide of lead ($Pb\,O$), sulphate of lead ($Pb\,S\,O_4$), and sulphide of lead ($Pb\,S$). The air is then excluded, and the temperature raised, when the sulphur becomes oxidised at the expense of the oxygen in the lead compounds, and escapes, as sulphurous anhydride, by the shaft, the pure metal remaining in the crucible. Galæna often contains a little silver, and sometimes even a little gold.

Lead is a soft, easily fusible metal, malleable, but not ductile. It is volatile by heat, and tarnishes readily in moist air, an oxide being formed on the surface of the metal.

It is very soluble in dilute nitric acid, but neither cold hydrochloric nor sulphuric acids have any action upon it. For this reason leaden chambers are used in the manufacture of oil of vitriol. Hot sulphuric acid, however, dissolves it, sulphurous acid being given off.

The pure metal is said not to be poisonous, but from the ease and rapidity with which most dilute acids act upon it, and its common use in everyday life, chronic poisoning by it is not uncommon. All the salts are poisonous, except, perhaps, the sulphide. Even a case of poisoning by the insoluble malate is recorded. ("Ann. d'Hyg.," published Jan. 7, 1842.)

Lead with Oxygen :—

Plumbous or Lead Suboxide	$Pb_2 O = 430$.
Plumbic or Lead Oxide (Litharge)	$Pb O = 223$.
Plumbic or Lead Dioxide	$Pb O_2 = 239$.
Red Lead = Mixture of the two Oxides	$\left\{ \begin{array}{l} (Pb O, Pb O_2), \text{ or} \\ (2 Pb O, Pb O_2) \end{array} \right.$
Plumbic or Lead Nitrate	$Pb 2 N O_3 = 331$.
Plumbic Acetate = Sugar of Lead	$Pb 2 (C_2 H_3 O_2)$.
Plumbic or Lead Carbonate	$Pb C O_3 = 267$.
Plumbic or Lead Sulphate	$Pb S O_4 = 303$.
Plumbic or Lead Sulphide	$Pb S = 239$.
Plumbic or Lead Chloride	$Pb Cl_2 = 278$.
Plumbic or Lead Iodide	$Pb I_2 = 461$.
Plumbic or Lead Oxalate	$Pb C_2 O_4 = 295$.
Plumbic or Lead Chromate	$Pb Cr O_4 = 323{\cdot}5$.

Carbonate of Lead ($Pb C O_3 = 257$).

(Ceruse—White Lead.)

Carbonate of Lead is found native. It may be prepared by precipitating sugar of lead with carbonate of soda. It is very heavy, and is usually found either in lumps or as a snow-white powder. It is largely used as a white paint, and was formerly employed for enamelling cards.

"White Lead" is an impure carbonate. It is prepared as follows :—A piece of metallic lead is so arranged that it may be freely exposed to acetic acid vapour given off from a little vinegar placed in the bottom of a small pot. It is then loosely covered over, and old tan thrown over the top, a number of pots being similarly arranged. In this manner the lead is exposed simultaneously to the action of air, vinegar, and carbonic acid from the decomposing tan. First of all, we have an acetate of lead formed. This lead acetate ($Pb 2 (C_2 H_3 O_2)$) takes up plumbic oxide, forming $Pb 2 (C_2 H_3 O_2) 2 Pb O$. This last ($Pb O$) takes up the carbonic acid given off from the tan, carbonate of lead being thereby ($2 Pb C O_3$) formed. The lead acetate dissolves more lead oxide, and so the process goes on until the action is retarded by the thick crust of carbonate on the surface of the lead. The crust is then removed, ground to powder, and sold as white lead. White lead is often adulterated with sulphate of barium, an impurity which would be known by its being insoluble in nitric acid. Carbonate of lead gives—(1) when heated on platinum a yellow residue, soluble in nitric acid; (2) it is blackened by sulphuretted hydrogen; and (3) it is soluble with effervescence in dilute nitric acid.

Sulphate of Lead ($Pb S O_4 = 303$).

Lead sulphate is a white, heavy, insoluble powder. It turns black with sulphuretted hydrogen, sulphuric acid remaining in solution. It is said not to be poisonous, because of its insolubility; but this is doubtful, for cases are recorded of sempstresses being poisoned by sucking thread that had been mixed with sulphate of lead for the purpose of increasing its weight. ("British Medical Journal," Jan. 19th and 26th, 1867, pp. 71 and 86.)

Sulphide of Lead ($Pb\ S = 239$).

This is found in nature as galæna. It is precipitated as a black hydrate, on passing sulphuretted hydrogen through a solution of a lead salt. It is decomposed by nitric acid.

Chloride of Lead ($Pb\ Cl_2 = 278$).

This is one of the three chlorides (viz., silver, lead, and mercurous) insoluble in water. At a moderate heat it fuses and becomes a horny mass (*Plumbum Corneum*).

Iodide of Lead ($Pb\ I_2 = 461$).

This is a yellow salt, soluble with difficulty in water.

Oxychloride of Lead ($Pb_4\ O_3\ Cl_2$).

(Mineral Yellow—Patent Yellow—Turner's Yellow—Cassel Yellow.)

Used as a paint.

Chromate of Lead ($Pb\ Cr\ O_4$).

The chromate is a yellow, insoluble salt. It has proved fatal from its accidental use by pastrycooks to colour buns, in order to give them a rich appearance. ("Medical Times and Gazette," Dec. 24th, 1859, p. 635.) It is also used to colour cheap confectionery.

Oxide of Lead ($Pb\ O = 223$).

(Ordinarily called "*Litharge*," or, when finely powdered, "*Massicot*.")

Lead Oxide is prepared during the extraction of silver from lead. It is more or less of a yellow colour. It is soluble in nitric acid, and possesses the property, when in contact with air, of absorbing carbonic acid from it. It melts at a red heat, and, when melted, freely dissolves glass and earthenware, forming fusible plumbic silicates. It is this property of litharge which renders it valuable in glass-making and in glazing earthenware.

Poisonous symptoms have often been produced by it. It is largely used by painters and glaziers, and also in the preparation of hair-dyes. Sometimes it is added to sour wines, to give them a sweet taste, and many accidents have arisen from its use for this purpose. Accidental cases of poisoning have resulted from the glaze on earthenware being dissolved by the action of dilute acids used in cooking. It has been supposed to be an abortive, and has been so administered, but it does not seem to be in any way an active poison, for a case is recorded where two tablespoonfuls were taken without any ill effects.

Red Lead ($Pb\ O,\ Pb\ O_2$). (Minium.)

Red Lead is made by heating litharge in the presence of air, whereby oxygen is absorbed. It is partly soluble in nitric acid; that is, the acid dissolves the Pb O, but not the $Pb\ O_2$. It is sometimes mixed with snuff, to give it a red tint, and has also been used for colouring wafers. It is a poison, and is often used in the manufacture of "beetle-wafers" mixed with flour and water. A case of death from these wafers is recorded. ("Medical Times and Gazette," March 1, 1851, p. 249). A case is also recorded where some red lead was left accidentally in a brewer's apparatus, and was not discovered until after some serious poisoning cases had occurred from persons drinking the beer with which it had been mixed. ("Lancet," March 19th, 1870, p. 428.)

The mere working in red lead has also produced serious symptoms. ("Medical Times and Gazette," December 27th, 1856, p. 643.)

Nitrate of Lead ($Pb\ 2\ N\ O_3 = 331$).

This is formed by dissolving lead or litharge in nitric acid. It is soluble in water. It is largely used in calico-printing. It forms the basis of Ledoyen's Disinfecting Fluid.

Acetate of Lead ($Pb\ 2\ (C_2\ H_3\ O_2)$)—(Sugar of Lead).

This is usually found in shops as a white, solid, crystalline mass, having an agreeable odour, and a somewhat sweet taste. It crystallises in four-sided prisms, which effloresce in dry air, a carbonate of the metal being formed. Its solution in water is sweet, colourless, odourless, and faintly acid to litmus. On spontaneous evaporation, white needle-shaped crystals are produced. One hundred grains are soluble in about 250 of water at ordinary temperatures, and in 6,500 of alcohol. It is insoluble in ether.

If heated moderately on a piece of mica it gives out its water of crystallisation, and becomes a white anhydrous mass. Heated still further, it again melts, and gives off vapours of acetic acid, the residual mass gradually becoming black. This residue consists of charcoal and metallic lead, and is of much greater bulk than that of the salt originally operated upon. No sublimate under such circumstances is produced. Heated with the blowpipe on charcoal, it melts, globules of metallic lead being formed, surrounded by a yellow incrustation of lead oxide.

Moistened with sulphide of ammonium, acetate of lead turns black, and with iodide of potassium or with chromate of potash solutions, yellow. If it be boiled with a little dilute sulphuric acid, acetic acid is given off, which may be recognised by its odour. If to this a little alcohol be added, and further heated, acetic ether will be formed, which will be known by its peculiarly fragrant apple-odour.

The solution of acetate of lead when added to common water renders it white and milky, an action due to the presence of sulphates and carbonic acid in the water.

It is not an active poison, although it is commonly supposed to be so.

A solution of sugar of lead will dissolve lead oxide (Pb O), when a tribasic salt is formed, called subacetate of lead, or Goulard's Extract ($Pb\ 2\ (C_2\ H_3\ O_2)\ 2\ Pb\ O$), which has the property of easily and freely absorbing carbonic acid, whereby an insoluble carbonate ($Pb\ C\ O_3$) is formed, the original acetate being left in solution.

Symptoms, Dose, &c.

First, we may notice the symptoms of acute lead poisoning.

Sugar of lead (for, toxicologically, this and the carbonate are the only two salts of much interest) is a weak, and rarely fatal, irritant poison. Dryness of the throat, a metallic taste, and thirst are complained of soon after it has been swallowed. Great, but often intermittent, abdominal pains of a colicky character, especially referred to the navel, and relieved on pressure, is the prominent complaint. The muscles of the abdomen are usually very rigid. The countenance is often very anxious, dingy, and heavy-looking, the pulse very feeble and very slow, and the prostration extreme. Sickness is not a constant symptom. There is (different from most irritant poisons) invariably constipation, from paralysis of the intestinal muscular coat. The urine is generally scanty, and very red. As the case progresses, violent cramps, cold sweats, paralysis of the lower extremities, and often convulsions and tetanic spasms, come on. The intellect usually remains clear to the last. Death during the stage of colic is almost unknown.

As to *the dose* of sugar of lead capable of producing acute poisoning, it is very difficult to speak with any degree of certainty. A dram of acetate of lead has been taken daily for ten days before any symptoms of poisoning manifested themselves. One ounce has been taken without any result whatsoever, whilst in other cases two drams has produced alarming symptoms. Cases are recorded ("Lancet," Oct. 23, 1841, p. 123, also p. 805) where mere medicinal doses have produced symptoms of acute poisoning. (See "St. And. Med. Grad. Trans.," vol. v., p. 226-7, for production of lead line after 18, 21, and 42 grains of this salt.)

As regards *the time* of its proving fatal, this is equally variable Two children died in thirty-six hours from swallowing Goulard's Extract. Deaths have occurred at the end of three days. We have no records of quantity in these cases.

Action of Lead Salts on Animals.

The experiments on animals of Orfila, Gaspard, Blake, Campbell, and others with lead salts, demand a passing notice here. It is difficult, on account of the vomiting produced, to kill a dog with sugar of lead. But if vomiting be prevented by tying the gullet, half an ounce of the acetate has been found to kill dogs in from nine hours to two days, the symptoms being those of acute irritant poisoning. Thirteen grains injected into the jugular vein of a dog killed it immediately. Five grains similarly administered killed a dog in five days, the symptoms not appearing until the third day, and no special post-mortem appearances being manifest in either case. Gaspard found that even two grains similarly injected would kill a dog; Campbell records a case of death by the application of sugar of lead to a wound; and others have noticed injurious results from the application of white lead to a scalded surface. ("Brit. and For. Med. Chi. Rev., Oct., 1857, p. 525.)

Christison found 400 grains of nitrate of lead killed a strong dog in sixteen hours, the appearances after death being those of an irritant poison. According to the experiments of Mitscherlich, half a gramme (7·7 grains) of the acetate, dissolved in water, given daily to rabbits, will cause death in from ten to twelve days. Very little effect was produced until the animal had taken six or seven doses. When ten grammes (= 154 grains) was injected into the stomach, death occurred in from three to twelve hours.

Experiments by several Continental toxicologists prove that effects can be produced in animals, as the result of small and long-continued doses, similar to those produced in man.

Lead may be found after death in the liver and kidneys, often in the spleen and urine, and generally in the muscles. It has been found in the milk of a cow poisoned with the carbonate.

Treatment of Acute Poisoning.

The proper antidotes to be given are the soluble alkaline and earthy sulphates, and of these sulphate of magnesia is undoubtedly the best. It is, however, advisable in the first instance to encourage free vomiting, with warm water or sulphate of zinc; whilst if these fail, the use of the stomach-pump should be resorted to. After this, sulphate of magnesia in milk, with eggs, may be given freely.

Opium may be necessary for the relief of pain, and purgatives, if the bowels be very costive. Injections are often useful. The carbonates which have been recommended as antidotes are broken reeds, carbonate of lead being itself a poison.

Chronic Lead Poisoning.

The causes of chronic lead poisoning are numberless. Nor is this to be wondered at, considering its extensive use in medicine and in the arts as well as in every-day life. Lead is a cumulative poison, and may be received into the system by all possible inlets—stomach, lungs, or skin. A few of the causes that have produced chronic lead poisoning are as follows. We have arranged them under three classes:

1. Where the lead was swallowed.
2. Where the lead was inhaled.
3. Where the lead was applied externally.

A. *Where the lead has been swallowed.*

1. By sucking pieces of lead. ("Lancet," June 12, 1869, p. 835.)

2. By the use of lead in confectionery as a colouring matter. ("Medical Times and Gazette," Dec. 24, 1859, p. 635.)

3. By the use of farinaceous foods that have been wrapped in lead foil. (See a similar case of curry powder, "Lancet," April 21, 1860, p. 406.)

4. By the use of leaden pipes for conveying acid beer or cider. ("Medical Times and Gazette," Aug. 31, 1867, and October 23, 1869. "Lancet," June 5, 12, and 26, 1869, pp. 779, 826, and 889.)

(See "Lancet," June 12 and 26, 1869, for a case where a publican had symptoms of lead poisoning, from taking every morning a glass of beer, which, being the first drawn, had been in contact with the lead pipes all night).

5. By drinking the water in lead mines, or the water kept in a leaden cistern ("Lancet," Feb. 22, 1851, p. 202,) or by the use of leaden pipes

for its conveyance ("Dublin Quarterly Journal," May, 1849; "Medical Gazette," vol. xliv., p. 260.)

6. By drinking wine impregnated with lead. ("Lancet," Aug. 3, 1867, p. 149.)

7. By the use of flour ground with stones that had been filled in with lead. ("Medical Times and Gazette," Dec. 22, 1866; "British Medical Journal," July 7, 1866, p. 7.)

8. By the use of glazed culinary vessels, which glaze is to a certain extent dissolved if acid liquids be boiled in contact with it.

(See case where *ginger-beer* produced lead poisoning from its having been made in glazed earthenware bushel pans. "Medical Times and Gazette," Nov. 21, 1868, p. 595.)

Milk and *cider* kept in glazed pans.—"Taylor's Medical Jurisprudence," vol. i., p. 302 (Dr. Proctor).

9. By the use of red lead as a cement for vessels containing food, or that are used for cooking purposes. ("Lancet," June 19, 1869, p. 870.)

10. By eating pickles, the jars containing them being capped with leaden tops. Soda water is also said to produce lead poisoning where the taps (patent syphon taps) have been made of lead.

11. By the use of sugar refined by lead, or sugar cast in moulds, the insides of which have been painted with white lead.

12. Occasionally by the use of lead medicinally. (The "Lancet," Oct. 31, 1863, p. 507. "St. And. Med. Grad. Trans.," vol. v., p. 226.)

13. By solder dissolved in Mulligatawny soup.

B. *Where the lead has been inhaled either in the solid or vaporous form.*

In some of these cases external application, as well as inhalation, will be the cause of the lead poisoning.

1. By sleeping in newly painted rooms. ("Lancet," Oct. 30, 1852, p. 391.)

2. By removing lead paint (scaling) by heat. ("Lancet," Aug. 2, 1873, p. 146.)

3. By the use of snuff and tobacco which has been wrapped in lead foil, or from the snuff being adulterated with red lead to give it a colour (Dr. Garrod). ("Lancet," Feb. 9, 1861, p. 152, and Dec. 3, 1870, and Jan. 6, 1872, p. 2; "Medical Gazette," xxxii., p. 138.)

4. Various businesses and trades.

   (α) Profession of artists. ("Taylor's Medical Jurisprudence," vol. i., p. 298.)
   (β) Inhalation of lead dust in cloth manufactories. ("Lancet," Dec. 24, 1864, p. 733.)
   (γ) Glass making. ("Lancet," Sept. 4, 1852, p. 214.)
   (δ) Sealing-wax making (carbonate and chromate of lead being used as colours.) ("Lancet," Sept. 4, 1852, p. 214.)
   (ε) House painting. ("Lancet," Aug. 15, 1868, p. 215; June 5, 1869, p. 779, August 2, 1873, p. 146.)
   (ζ) Lead soldering. ("Lancet," Sept. 4, 1852, p. 214.)

Three curious cases are recorded of lead poisoning in persons engaged in an underground kitchen of the London Railway Terminus, where leaden pipes were used for the conveyance of the steam.

C. *Where the lead has been applied externally.*

1. Various trades and businesses.

(α) White lead grinders. Since the system of grinding under water instead of as formerly, in a dry state, has been introduced, the number of cases of poisoning from this cause has much diminished. (See a fatal case, "Medical Times and Gazette," Nov. 26, 1864, p. 569.)
(β) Plumbers, painters, lead pipe makers, and workers in lead-mines. ("Medical Times and Gazette," Nov. 28, 1868, p. 611.)
(γ) Manufacturers of glazed cards (Lead for this purpose is not used now, because the cards so easily turn black). ("Lancet," Sept. 4, 1852, p. 214.)
(δ) Litharge makers, pottery workers, and glass blowers.
(ε) Workers in red lead. ("Medical Times and Gazette," Dec. 27, 1856, p. 643.)
(ζ) The handling of vulcanized rubber coloured with lead. ("Pharmaceutical Journal," 1870, p. 426.)
(η) The working in black glazed cloth (overland cloth). ("British Medical Journal," Sept. 24, 1870, p. 325.)
(θ) The cleansing and handling pewter pots (barmen) ; ("Medical Gazette," vol. xlviii., p. 1047 ; "Lancet," Jan. 21, 1860, and Aug. 15, 1868, p. 215), and cleansing lead counters, such as are used by fishmongers, with brine. ("Guy's Forensic Medicine," p. 482.)
(ι) Type handling. ("Lancet," Sept. 4, 1852, p. 214.)
(κ) Manufacture of organ pipes. ("Lancet," Dec. 3, 1870, p. 781.)
(λ) Japanning. ("Lancet," Aug. 15, 1868, p. 215.)
(μ) Gas and engine fitting. ("Lancet," June 5, 1869, p. 779 ; "Medical Times and Gazette," Nov. 28, 1868, p. 611.)

2. The use of hair dyes and cosmetics. ("Pharmaceutical Journal," Nov. 1869, p. 304 ; "Lancet," Sept. 4, 1852, p. 214, Jan. 12, 1861, p. 44 ; "Medical Times and Gazette," Oct. 10, 1868, p. 433 ; "British Medical Journal," Oct. 17, 1874, p. 513.)

3. The working in lead dyes, such as Chromate of lead. ("British Medical Journal," Aug. 3, 1872, p. 131. Fatal cases recorded, "Medical Times and Gazette," Dec. 24, 1864, p. 692.)

4. From the action of white leather linings to hats, which often contain large quantities of carbonate of lead.

5. "American cloth" often contains lead.

Of 1213 cases of chronic poisoning collected by M. des Planches, 406 occurred amongst manufacturers of white lead, 305 amongst house-painters, 68 amongst colour-grinders, 63 amongst red lead manufacturers, 54 amongst manufacturers of common earthen pottery, 52 amongst type-founders, 47 amongst carriage-painters, 35 amongst lapidaries, 33 amongst ornamental painters, and the remainder amongst a large number of trades.

The fact, then, is this, that in whatever form lead be constantly or habitually applied to the body, whether it be the inhalation of the fumes, or its accidental administration with foods (see a series of cases recorded by Dr. Taylor, of Guildford, "Lancet," March 19, 1870, p. 428), or its exhibition as a medicine, either given internally, or applied externally as an unguent (as *e. g.*, to piles or sore nipples), the symptoms of chronic lead poisoning may be set up. It has been stated that the women in factories are not so easily affected by lead as men ("Lancet," Oct. 4, 1856. See also Lecture by Sir J. Alderson, "Lancet," July 24, 1852, p. 98.)

Symptoms of Chronic Lead Poisoning.

The symptoms may be, and often are, slow in their progress. Obstinate constipation and indigestion, with an intense feeling of depression may be all the patient at first complains of. Then there follows in due course a loss of appetite, an unrelievable thirst, a constant unpleasant metallic taste, and an extreme fœtor of the breath. The countenance becomes dull and heavy, and appears anxious. There is rarely any fever, and the pulse is usually natural. The respiration is often rapid. There is frequently great abdominal hardness and pain, relieved by pressure, either at the pit of the stomach, about the navel, or in the region of the colon (*colic*), the pain increasing in intensity as the case progresses. The navel will often be noticed to be drawn inwards. Obstinate constipation is a common symptom, or if the bowels act, the motions are passed with pain and are dark coloured, from sulphide of lead being formed. There is usually but little urine passed, and a difficulty in passing it. In the female vaginismus is a common symptom. Dr. Roque asserts that slow lead poisoning, whether in the father, or the mother, predisposes to miscarriage, and often produces convulsions, idiocy, imbecility, and epilepsy in the children ("Medical Times and Gazette," Aug. 18, 1860, p. 167). Moreover, in chronic saturnine poisoning a peculiar delirium, especially occurring of a night (Delirium of Dread), is not uncommon ("Medical Times and Gazette," Feb. 27, 1869, p. 222). The case may terminate favourably without any further bad symptoms, whilst, sometimes, a form of apoplexy is set up which rapidly proves fatal with coma and convulsions.

But far more commonly *Lead Palsy* manifests itself. We are told that paralysis is commoner in boys and girls, and colic in adults. Lead palsy may occur after a single attack of chronic lead poisoning, but it is more frequently the result of a succession of attacks, whilst occasionally it comes on without being preceded by any attack at all. It is to be particularly noted that the upper extremities, and especially the extensor muscles, are those most commonly attacked, and that the muscles which are the first to lose power and waste away are the extensor muscles of the hand and forearm. And this is the history of "the dropped hand" of chronic lead poisoning.

But we have yet to notice the great diagnostic sign of saturnine poisoning, a sign that may be discovered when the cause of the patient's illness is often neither suspected by the patient nor his friends;—that is, the *blue line* in the gums, around the margin of the teeth. It is rarely absent, and, as a rule, is a very early symptom. Dr. Fleming records a case, however—which is worth noting, of lead poisoning occurring in an infant before it had any teeth, and in this case no blue line was apparent in the gums (British Medical Journal, January 14, 1865, p. 27).

This blue line is not due, as some have supposed, to a deposit of the metal on the epithelium cells, but to the formation in the minute capillaries of the gums of a sulphide of lead, produced by the action of sulphuretted hydrogen derived from the fluids of the mouth, on the lead circulating in the capillaries. If the blue line be examined with a highly magnifying lens, it will be seen that the capillaries are dotted with blackish granules.

The subject of chronic lead poisoning has been of late carefully investigated by Heubel ("Virchow und Hirsch's Jahresber." 1871, vol. i., p. 316). The bones in these cases were found to contain the most lead, then the liver and kidneys. The muscles, blood, and intestines contained less than other parts, even than the brain and spinal cord. He denies, therefore, what Henle asserts, that lead has a special affinity for muscle, or that the poison exerts a specific action on the pale and striated muscular fibres; nor does he consider that the colicky pains are due to pressure of the contracted muscular fibres on the ends of the sensory nerves. The constipation and diminution of urine he attributes to abnormal irritation of the splanchnic nerve; whilst the muscular atrophy he traces to the general affinity of the nerve tissue for the poison.

Iodide of Potassium is regarded by many as the great remedy in chronic lead poisoning. It should be given in doses of from five to ten grains three times daily. There is, however, strong reason to doubt whether this treatment is always so successful as many seem to suppose. Soluble sulphates (sulphate of magnesia) with dilute sulphuric acid (first suggested in 1831 by M. Gendrin) seem the most efficacious treatment under ordinary circumstances. The use of purgatives mixed with anodynes, as, for example, opium and castor oil, has proved very useful. Some recommend a full dose of a laxative salt to be given first, followed in an hour by the opium. In severe cases croton oil has been found of service. Mercury given to salivation has been said to have relieved the colic when other things failed, but the authors consider this to be bad practice.

In the advanced state of the disease, when the dropped hand is the prominent symptom, the patient must entirely give up business, take constant exercise in the open air, and be allowed a generous diet. Friction and electricity may be used with advantage, and strychnia given internally has proved beneficial.

Once a patient has suffered from lead poisoning, the chances are that, if he is exposed to similar conditions, he will have a repetition of the disease. The prophylactics, therefore, are a matter of great importance.

1st. And above all, *great cleanliness* must be observed. Workmen, unfortunately, are not, as a rule, very clean. Frequent bathing and washing with soap, the use of sulphurous baths, rinsing the mouth out from time to time and combing the hair thoroughly, should never be neglected.

2ndly. The clothes of workmen should not be made of *woollen* material, but of *compact* linen; these should be washed frequently and changed for other clothes upon leaving the workshop. A cap should be worn whilst at work.

3rdly. No meals, or food should be allowed to be eaten in the workshop. Before eating, the hands should be well washed, the nails cleaned, and the teeth brushed.

4thly. The diet should be easily digestible. Vinegar, sour beer, and tart wines (such as are often drunk on the Continent) should be avoided. Fatty foods are said to be good.

5thly. Liebig and M. Gendrin advise that lemonade, or sugared water acidulated with sulphuric acid should be provided for the work people as a beverage during work hours.

6thly. The workshop must be well ventilated with free currents of air, so as to carry away floating lead particles. All the operations of grinding in "white lead factories" should be conducted under water.

7thly. At the very first indication of lead poisoning the work must be discontinued, and proper treatment at once adopted. Medicine should, in all cases, be occasionally taken by the workmen, even when well, in order to prevent constipation; and for this purpose sulphate of magnesia is to be preferred to all other purgatives.

Action of Water on Lead.

It is of importance here that we should consider carefully the action of water on lead in connection with the important medical question of chronic lead poisoning.

And note—

1st. That pure distilled water, freed from any dissolved gases by boiling and excluded from contact with air, has no action whatsoever on lead.

2ndly. If the distilled water containing its customary gases, be brought into contact with lead, the surface of the water not being exposed to the air, the lead soon becomes dull and white, but the action of the water on the lead is very temporary and limited.

3rdly. If distilled water, or any pure water, such as rain water, snow water, or the water of some rivers and springs, be allowed to act upon lead in the presence of air, the action is energetic and the lead is certain to be more or less dissolved. The chemical process whereby this is effected is important. An oxide of the lead is formed. This is slightly soluble in water. The solution then absorbs carbonic acid from the air. The carbonic acid precipitates the lead in great part from the water as a hydrated oxy-carbonate ($Pb\,O, H_2O, Pb\,CO_3$). When this is precipitated the water dissolves fresh oxide, which is again precipitated by the water absorbing fresh carbonic acid, and so on. Rain-water, therefore, collected in leaden pipes from the roofs of houses is not unlikely to be seriously contaminated with lead.

4thly. Certain circumstances modify the action.

(α) Circumstances *increasing* the corrosive action of water on Lead.

Such for example as the presence in water of chlorides, nitrates and nitrites.

(β) Circumstances *decreasing* the corrosive action of water on Lead.

Such as the presence of sulphates, phosphates, and carbonates. And for this reason a hard water, so far as lead is concerned, is a safe water. 1 part of sulphates in 5000 parts of water interferes with, if not entirely prevents the action of the water upon lead. A water, such as is supplied to the city of London, of twelve or thirteen degrees of hardness before and three degrees after boiling, is absolutely without solutive power on lead. In nearly all town waters the amount of carbonate of lime present is sufficient to prevent injurious action. A film of insoluble basic carbonate is formed, and being once formed protects the lead from further corrosion. Spring waters may, as a rule, be considered without action on lead at all.

A little vegetable matter in water is said to act as a preservative, as in the Scotch lake waters, where an insoluble lining to pipes and cisterns is formed by its combination with the lead oxide.

5thly. The practical conclusions to be drawn from these facts are that:—

(α) Lead should not be used at all for the storage of water. Cisterns should be made, if required, of slate. It is better, however, not to store water in private houses at all. The distilled waters of aromatic plants should never be kept by druggists in leaden vessels, as this may be a cause of accident.

(β) Iron or earthenware pipes for conveying water are preferable to lead.

(γ) No pump should have a lead cover, as the water that rises by evaporation is very pure and therefore freely dissolves lead. This, dropping down into the pump, may serve to contaminate the water of the well.

(δ) The use of tinned pipes is objectionable. If the layer of tin is not perfect in every point, a galvanic action is likely to be set up and the solution of the lead hastened accordingly. The solder, moreover, used in leaden cisterns may by galvanic action assist the solution of the lead. Even impurities in the lead itself may in a similar manner act injuriously.

6thly. To test whether a water has any action upon lead, thoroughly clean some strips of lead by scraping them with a piece of glass, and place them in a tumbler full of water, allowing the whole to be freely exposed to the air. At the end of three days remove the pieces of lead and pass sulphuretted hydrogen through the water and observe whether any blackening of the water results. The change of colour is best seen by standing the glass on a piece of white paper in a good light.

Action of Acids on Lead.

It is important to notice the action of acids on lead.

1. *Sulphuric Acid.*—A trace of sulphuric acid added to distilled water greatly decreases its solutive power.
2. *Hydrochloric Acid.*—One part in 3000 of water largely increases the solvent power of the water.
3. *Acetic Acid.*—One part in 10,000 of water largely increases the solvent action, provided a free supply of air be maintained.
4. *Citric Acid* increases the solvent action, but to a lesser degree than acetic acid.
5. *Tartaric Acid* also increases the solvent action, but to a lesser degree than citric acid.
6. *Malic Acid.*—One part in 5000 of water, if allowed to be in contact with lead for one hour, will show a marked reaction with sulphuretted hydrogen.

This action of acids on lead will serve to explain some of the evil effects that have resulted from the storage of various articles of food in leaden vessels or in dishes glazed with lead. For example, milk that has been kept in glazed earthenware pans has been a cause of lead poisoning. Rum being preserved in leaden vessels was proved to have produced an epidemic colic in Jamaica. Wine being placed in bottles where lead shot had been used for cleaning the bottle, and the shot not entirely removed, has been a cause of accident; whilst the lead-colic that at one time was so common in Devonshire was clearly traced to the contamination of the cyder with lead, and that not merely caused by the addition of a lead salt in order to correct acidity, but to its contact with metallic lead in the apparatus used in the manufacture.

And here it may be mentioned that wines were formerly much adulterated with lead for the purpose of correcting their acidity. The "*Colica Pictonum*" derives its name from the sixteenth-century outbreak of colic at Poitou, which raged for sixty and more years, brought about, it is believed, by such admixture. This method of sweetening wines is not adopted now-a-days, but the acetate of lead has been and is still used for the purpose of clarifying not only wines and spirits, but also sugar.

Post-Mortem Appearances.

Often in an acute case no well-marked appearances have been discovered. At other times more or less inflammation of the intestinal tract has been observed. Sometimes the stomach has appeared white, as if corroded by the poison. The intestines have generally been found contracted.

As regards chronic cases there is nothing definite to be recorded, save the constriction and contraction of the large intestines, and the flabby and whitish appearance of the muscles specially affected. They may even be reduced to the general aspect of white fibrous tissue. In cases where convulsions have preceded death, no special morbid appearances, such as we should expect, have been discovered in the head.

M. Tanquerel, after an elaborate inquiry into the post-mortem appearances of lead poisoning, concludes that the pathological phenomena are not caused by such anatomical changes as are cognizable by the senses.

Tests.

1. *Sulphuretted Hydrogen.*

Gives in neutral, acid, or alkaline solutions, a black precipitate (PbS). In very dilute solutions the precipitation of the sulphide of lead may be considerably aided by heat. The precipitate is insoluble in caustic alkalies or in dilute mineral acids. It is soluble in hot hydrochloric acid.

To further test the precipitate, boil it in dilute nitric acid for fifteen minutes (one of acid to four of water) and filter. Test the filtrate for lead as follows:—

(α) Evaporate a drop of the solution to dryness, and so obtain slender prismatic crystals of nitrate of lead.
(β) *Iodide of potassium* gives a yellow precipitate (*vide* 2).
(γ) *Chromate of potash* gives a bright yellow precipitate (*vide* 6).
(δ) *Dilute sulphuric acid* gives a white precipitate (*vide* 3).

2. *Iodide of Potassium.*

Gives, in solutions neither very acid or alkaline, a bright yellow precipitate (PbI_2) insoluble in excess of the iodide; soluble in caustic potash, forming a clear solution, as well as in nitric and hydrochloric acids; sparingly soluble in cold water; soluble to a slight extent in boiling water, from which it is reprecipitated on cooling in golden six-sided scales. It is less soluble in water containing iodide of potassium than it is in pure water.

3. *Sulphuric Acid and the Soluble Sulphates.*

Give a white heavy precipitate of sulphate of lead ($Pb\ SO_4$), which in dilute solutions subsides somewhat slowly.

The precipitate is insoluble in dilute nitric acid, but is soluble in boiling hydrochloric acid and in a large excess of potash and soda.

(Note.—Sulphuric acid also precipitates baryta and strontia, but $Pb\ SO_4$ may be known either by its turning black when touched with sulphide of ammonium, or when mixed with carbonate of soda and heated on charcoal with the blow-pipe, by its yielding a globule of metallic lead.)

4. *Hydrochloric Acid* and *Soluble Chlorides.*

Give a white precipitate with strong solutions of lead salts, the precipitate being sparingly soluble in water (1 in 120), but soluble in hot hydrochloric acid.

(Note.—Hydrochloric acid also gives a white precipitate with solutions of silver and sub-oxide of mercury. Both of these are quite insoluble in water. The one may be known from the other as follows:—

Add to the precipitate a solution of ammonia.
The Lead Chloride is insoluble and is not altered in colour.
The Silver Chloride is perfectly soluble.
The Mercurous Chloride turns black.)

5. *Zinc Test* (The Lead tree).

(α) Suspend by a thread of silk a piece of pure zinc in a lead solution, when metallic lead will be deposited upon the zinc.

(β) Put the lead solution into a platinum capsule, acidulate it with acetic acid, and touch the platinum through the lead solution with a piece of zinc, when metallic lead will be thrown down on the platinum, and may be tested accordingly.

6. *Chromate of Potash.*

Gives, in neutral solutions, a bright gamboge-yellow amorphous precipitate of *Chromate of Lead*, which is insoluble in acetic acid, is very soluble in caustic potash, and is blackened when acted upon by sulphide of ammonium.

7. *Oxalate of Ammonia.*

Gives, in neutral solutions, a white precipitate of oxalate of lead, which is soluble in nitric acid, insoluble in acetic acid, blackened by sulphide of ammonium, and yields a metallic bead when heated on charcoal with the blow-pipe.

8. *Alkaline Carbonates.*

Give a white amorphous precipitate, insoluble in excess of the precipitant, but soluble in potash and soda and in nitric and acetic acids.

9. Lead solutions also give white precipitates with potash, ammonia,

and ferrocyanide of potassium, and a yellow precipitate soluble in ammonia with ferricyanide of potassium.

10. All lead salts mixed with carbonate of sodium and heated on charcoal in the reducing flame of the blow-pipe, are reduced to a malleable metallic bead of the metal surrounded more or less by a ring of yellow oxide.

Toxicological Analysis.

A. (*a*) In conducting a toxicological inquiry, treat the contents of the stomach and any tissues to be examined, previously well broken up in a mortar, with sufficient water to filter easily ; acidulate with nitric acid, boil for a few minutes, filter, and treat the filtrate with washed sulphuretted hydrogen.

But it must not be forgotten that the lead salt may be present in an insoluble form from its having been precipitated either by the several antidotes administered, or by the casein albumen, &c., normally present. Proceed now as follows :

(β) Incinerate all the materials on the filter paper in a porcelain capsule. Dissolve the ash by heat in dilute nitric acid, filter, and pass sulphuretted hydrogen through the filtrate.

The black precipitate must now be proved to be lead by the several tests already described.

If an alkaline sulphate has been given as an antidote, a white precipitate of sulphate of lead may be found in the stomach. This should be collected, boiled in *pure* caustic potash (taking care it is itself free from lead), and the solution tested with sulphuretted hydrogen.

B. The contents of the stomach and the tissues may be boiled with a little carbonate of soda, and filtered. Add a little acetic acid to the residue on the filter, and wash with water. Put these washings and the filtered liquid together, pass sulphuretted hydrogen through it, collect the sulphide, and weigh.

(C.) The process of Fresenius and also Dialysis have been recommended by some for the recovery of the poison.

(D.) In the case of sweetmeats suspected of being coloured with lead, slightly moisten them with water and put them on a plate, placing in the centre a little capsule containing a dram or two of sulphide of ammonium, and cover the whole over with a tumbler. If lead be present the sweetmeats will after a short time be found to be blackened by the sulphuretted hydrogen evolved.

(E.) To examine water for lead, two clear white pint bottles should be taken and filled with the water to be examined. Through the one washed sulphuretted hydrogen should be passed for some time, and the colour should then be examined, by comparison with the water in the other bottle in a good light, to see whether any blackening effect has been thereby produced.

Quantitative Estimation.

To estimate lead quantitatively we precipitate it as a sulphide:

If a liquid, evaporate to dryness, expose to a red heat with charcoal and carbonate of soda (black flux), dissolve in nitric acid, dilute, neutralize with ammonia and precipitate with sulphuretted hydrogen, collect, dry, and weigh.

100 grains of PbS = 93·31 of PbO (Litharge)
" = 107·53 of $PbCO_3$
" = 138·49 of $Pb2NO_3$
" = 158·37 of crystallized acetate of lead.
100 grains of $PbSO_4$ = 125·00 of acetate of lead.

Cases of Poisoning by the Salts of Lead.

(I.) ACETATE OF LEAD.		
1. "Lancet," Aug. 25, and May 5, 1849, p. 205 (Dr. Norris). The Stourbridge case. 30 lbs. of acetate of lead by mistake for alum mixed with 70 or 80 sacks of corn.		
Symptoms.—No deaths. Blue line observed in gums in nearly all the cases (over 120); salivation in several cases; pains in the loins very frequent.	*Result.*—Recovery.	
2. "Medical Times and Gazette," March 20, 1858, p. 296 (Dr. Leared). Male. 1 oz. dissolved in water.		
Symptoms.—Vomiting in a quarter of an hour and purging in three-quarters; constipation.	*Result.*—Recovery.	
3. "Medical Times," Dec. 26, 1840, p. 149. Female. About 600 grains.		
Symptoms.—Immediate fainting, convulsions, and vomiting; a large quantity of urine was passed, and found by Orfila to contain a large quantity of lead. No cerebral symptoms, or numbness.	*Result.*—Recovery.	
4. "Medical Times," Sept. 13, 1865, p. 471. Female: æt. 24. ℥ss.		
Symptoms.—Immediate burning pain in stomach, and sickness; mouth became white; carotids pulsated violently.	*Result.*—Recovery.	
5. "Provincial Medical Journal," April, 1846 (Mr. Gorringe). (1) Female. 1oz.		
Symptoms.—Vomiting; pain. Suffered for more than a year from dyspepsia.	*Result.*—Recovery.	
6. "Provincial Medical Journal," April, 1846 (Mr. Gorringe). (2) Female. 1oz.		
	Result.—Recovery.	
7. "Lancet," April 4, 1846, p. 384. Female. 60 grains.		
Symptoms.—No paralysis.	*Result.*—Recovered in 3 weeks.	

8.

"Transactions of the College of Physicians, London," vol. iii. p. 426 (Sir George Baker). Male: adult. ʒj, taken in two doses.

Symptoms.—In five hours great pain; vomiting; delirium.	*Result.*—Recovery.	

9.

"Bulletin de la Soc. Roy. de Méd.," 1840, vol. vi., p. 283. Female: adult. ℥j.

Symptoms.—No bad symptoms. Lead found in urine.	*Result.*—Recovery.	

10.

"London Medical Repository," 1824, vol. iii., p. 37 (Mr. Iliff).

Symptoms.—Pain, rigidity, numbness, lasting for some days. At first there was vomiting and colic.	*Result.*—Recovery.	

(II.) GOULARD'S EXTRACT (SUBACETATE).

11.

"Lancet," Jan. 14, 1860 (Dr. Aldis). Female: æt. 21. ¾ pint.

Symptoms.—Great agony; muscles of belly drawn inwards; trembling of hands; no vomiting or purging, but desire to vomit; great thirst.	*Result.*—Recovery.	

12.

"Lancet," March 3, 1838. Male: adult. Taken, believing it to be wine.

Symptoms.—On the third day severe colic, loss of voice, locked jaw, and convulsions.	*Result.*—Death on third day.	

13.

"Journal Universel," vol. xx., p. 351. Male: adult. Dose?.

Symptoms.—Severe colic on third day.	*Result.*—Death in 3 days.	

(III.) LITHARGE.

14.

"Lancet," May 24, 1873, p. 733. Female: æt. 30. Two tablespoonfuls of litharge to bring on menses.

Symptoms.—No poisonous symptoms of any kind.	*Result.*—Recovery.	

(IV.) RED LEAD.

15.

"Guy's Hospital Reports," Oct., 1850, p. 209. Female: adult. ℥ij¼.

Symptoms.—No symptoms for 9 hours.	*Result.*—Recovered in 12 days.	

16.

"Lancet," 1870, vol. i., pp. 428 and 495 (Dr. H. S. Taylor). A series of cases caused by some beer made at a brewery where a quantity of red lead had been accidentally left in one of the brewing utensils.

	Result.—One fatal case.	

(V.) CARBONATE OF LEAD.

17.

"Lancet," Oct. 26, 1844, p. 144 (Mr. Snow). Male: æt. 5. Piece of white lead size of a marble.

Symptoms.—Had pain and costiveness for 3 days. On the third day vomiting came on. The body became covered with petechiæ; gums tense and very white. Died in 90 hours.	*Result.*—Death in 90 hours.	*Post-mortem.*—Quantity of bloody fluid in pericardium; lungs engorged; liver, heart, and kidneys soft and flabby; stomach intensely inflamed; intestines natural. Lead not found.

18.

Casper's "Wochenschrift," No. 36, 1844; "Medical Times," Aug. 16, 1845, p. 390. Male: æt. 20. ʒv to ʒvj in mistake for chalk.

Symptoms.—Vomiting and pains in a few hours. Severe thirst and constipation.	*Result.*—Recovery.	

19.

"Medical Times," Feb. 23, 1839, p. 786 (Mr. R. Cross). Female: æt. 33. ʒvi to ʒviii.

Symptoms.—Symptoms set in in five hours. Sulphate of magnesia administered.	*Result.*—Recovery.	

20.

"Christison," p. 552 (Dr. Ogsten). Female. ℥j.

Symptoms.—No effect.	*Result.*—Recovery.	

21.

"Christison," p. 552 (Mr. Cross). Female. ʒvj.

Symptoms.—Violent symptoms for eight hours.	*Result.*—Recovery.	

MANGANESE.

(Mn = 55).

This metal is widely diffused. Its attraction for carbon is so very great that it is difficult to obtain it in a pure state. It is a hard, brittle, grey, and feebly magnetic metal. The manganates are all coloured.

Preparations of manganese have been proposed and used in medicine. The sulphate, in doses of from 60 to 120 grains, is said to have a purgative effect, and to increase the excretion of bile. Its value in cases of anæmia is, however, very doubtful. It colours the fæces pink or golden yellow.

Manganese is a feeble poison. A dram proved fatal to a rabbit in an hour. Twelve grains injected into the jugular vein of a dog killed it in five days, the stomach, liver, and duodenum being found inflamed. Hünefeld found manganic acid might be given to a rabbit for two or three days, in doses of ten or fifteen grains, without producing any effect except an increased flow of urine. The liver, however, on analysis, yielded manganese. Dr. Couper of Glasgow has asserted that manganese is an insidious poison and induces paraplegia, whilst, on the other hand, Dr. Thomson of Glasgow states that an ounce of the sulphate is a safe laxative.

Tests.

1. *Sulphide of Ammonium* gives a buff-coloured precipitate ($Mn\ S$), soluble even in acetic acid.

2. *The Alkalies* give a white precipitate of hydrated oxide ($Mn\ HO_2$), which becomes brown from the formation of $Mn_2\ HO_4$.

3. Mixed with sodium carbonate and heated on platinum foil in the oxidizing flame of the blow-pipe, a fusible mass of a green colour is produced ($Na_2\ Mn\ O_4$).

4. Heated in a borax bead in the oxidizing flame of the blowpipe, a magnificent amethyst red bead is formed.

MERCURY.

(Symbol Hg—Atom. wt. 200 ; Sp. gr. at 0° 13·596 ; of Vapour 6·976 ;
Melting Pt. 39° C. ; Boiling Pt. 350° C.)

Mercury is the only metal liquid at ordinary temperatures. It is extracted from a red ore called cinnabar ($Hg\ S$). It is attacked by all the haloid elements, and dissolves most of the metals, except iron and platinum. It is dissolved by hot nitric and sulphuric acids, whilst hydrochloric acid has no action upon it. It volatilizes at all temperatures above 4° Cent., and boils at 350° Cent. when it passes off unchanged. When pure it is not tarnished by exposure to air, but if kept at a temperature of 300° it slowly absorbs oxygen and becomes converted into the red oxide.

Mercury is not a constituent of the human body, nor is it a poison except it becomes oxidized. If the vapour be breathed, or if it be applied in a finely divided state to an ulcer or to the abraded skin, or even to the sound skin, as happens with those who are engaged in mining the metal, then the various symptoms indicative of mercurial poisoning may be produced ("Lancet," Jan. 11, 1868, p. 68). In all these cases, however, the action is not produced by the pure metal, but by oxidized products. The blue pill and blue ointment of the pharmacopœia, both of which are made with the metal, are always found to contain more or less of an oxide. Thus the "blue ointment" has more than once proved fatal to sheep from its being used as a wash for the fly, and, moreover, no doubt more or less impregnates the flesh, thereby rendering it unfit for food. In all samples of "Hyd. c̄ Cret." some of the mercury will be found to have become oxidized, and for this reason grey powder is a somewhat uncertain preparation, as the amount of the oxide formed varies considerably according to the length of time it has been made, and the extent to which it has been exposed to air and sunlight.

This fact may be important in explaining some anomalous cases that are on record of poisoning from "Hyd. c̄ Cret." and from other mercurial preparations.

The most important compound of mercury from a medico-legal point of view, is corrosive sublimate. We must therefore deal with this in some detail. Other preparations have from time to time been used for criminal purposes, and these we shall briefly notice. We append a table of some of the mercurial salts, many of which, however, are of but little interest or importance toxicologically.

Mercuric Chloride, or Perchloride of Mercury (Corrosive Sublimate)	$Hg\ Cl_2$
Mercurous Chloride or Subchloride of Mercury (Calomel)	$Hg\ Cl$
Ammonio Chloride of Mercury (White Precipitate)	$NH_2\ Hg''\ Cl$
Mercuric Oxide (Red Precipitate)	$Hg\ O$
Mercurous Oxide (Black)	$Hg_2\ O$
Mercuric Sulphate	$Hg\ SO_4$
Mercurous Sulphate	$Hg_2\ SO_4$
Mercuric Oxy-sulphate (Turpeth Mineral)	$Hg_3\ O_2\ SO_4$
Mercuric Sulphide (Vermilion)	$Hg\ S$
Æthiops Mineral—Mixture of Sulphide of Mercury and Sulphur	
Mercuric Nitrate	$Hg\,2NO_3 2H_2O$
Mercurous Nitrate	$Hg\ NO_3$
Mercuric Iodide (Red Iodide)	$Hg\ I_2$
Mercurous Iodide (Green Iodide)	$Hg\ \underline{I}$
Mercuric Cyanide	$Hg\ Cy_2$
Mercurous Chromate	$Hg_2\ Cr\ O_4$

Corrosive Sublimate or *Mercuric Chloride* ($Hg\ Cl_2$).

(Bichloride, Chloride, Oxymuriate, Perchloride).

It is prepared by subliming a mixture of common salt and mercuric sulphate.

It is a powerful antiseptic. Wood and canvas are often soaked in a solution of the salt on account of its preservative power. It is used in the preservation of skins, for the destruction of vermin in man and animals, and also as a medicine for syphilis, &c.

It is met with both as a white powder, and in a crystalline form (Rhombic Prisms), the crystals being permanent in the air. It has no smell, but its taste is intensely metallic. It has a specific gravity of 6·6.

Heated on platinum foil it melts, and at a temperature of 93·3° Cent. it sublimes in the form of stellate crystals. At 295° Cent. it boils, no residue being left on the foil. This complete volatilization is likewise characteristic of ammonia salts, of oxalic acid, and of arsenious acid. Its solubility in various liquids is as follows:

9 grains of Corrosive Sublimate dissolves in	100 of water (10° Cent.)
48 „ „ „ „	100 of water (100° Cent.)
30 „ „ „ „	100 of alcohol.
35 „ „ „ „	100 of ether.
1 „ „ „ „	1,700 of chloroform.

It is decomposed by the fixed alkalies. It is not acted upon by sulphuric acid, but is soluble in nitric and hydrochloric acids. Albumen, fibrine, casein, gluten, gelatine, tannic acid, &c., decompose and precipitate it when in solution. Its solution or the crystals formed by evaporation or sublimation are turned *black* by sulphide of ammonium, *scarlet* by iodide of potassium, *yellow* by caustic potash or soda, and *black* by chloride of tin. If heated with three or four times its bulk of carbonate of soda, the metal is reduced.

Its solution in water is feebly acid to litmus paper.

Symptoms, Dose, &c.

The symptoms in an *acute* case of mercurial poisoning set in very soon, and in many cases immediately after the poison has been swallowed, the interval at most being only a few minutes. An intensely nauseous metallic taste and a fiery burning pain from throat to stomach are the first symptoms. The tongue and mouth appear white and shrivelled as if washed with a solution of caustic silver, and the face flushed and intensely anxious. The other symptoms usually observed, are difficulty in breathing, a small thready pulse, abdominal swelling and pain, which is generally greatly increased on pressure (although curiously pain is sometimes absent), intense thirst, vomiting of white stringy or bloody mucus, bloody stools, cold and clammy skin, and a more or less complete suppression of urine. Salivation sometimes sets in about the third day, although in acute cases this is not an invariable symptom. Death is sometimes rapid from collapse, sometimes accompanied with convulsions, whilst at other times there is complete and intense coma from which the patient never rallies.

The symptoms of poisoning by corrosive-sublimate may be diagnosed from those of arsenic by:—

1. Their commencing sooner after the poison is swallowed.
2. The intensely metallic taste of corrosive sublimate.
3. The intense burning produced in the throat and gullet.
4. The greater frequency of blood in the vomit and stools.

It is a more actively poisonous drug than arsenic, because it is more soluble and has more powerful chemical reactions on animal structures.

Three grains is the smallest quantity that has proved fatal. A case of five grains destroying life is recorded. Recovery has taken place after eighty grains. Children are less susceptible to its action than adults, the reverse being the case with opium. We are disposed to doubt, without much better verification than we at present possess, the stories of men who are said to have acquired a habit of eating corrosive sublimate until they could take a dram of it daily. So runs the story of the celebrated Turk. Its external application has proved fatal.

Death has been as rapid as half an hour, whilst it has been delayed for sixteen days. From three to six days is the average.

Treatment.

White of egg in milk, or else wheat flour mixed with milk, should be given immediately. The white of one egg is said to be able to neutralize four grains of corrosive sublimate (Dr. Peschier). It has been stated that too much albumen may be given, the compound formed being soluble in excess ("Lancet," May 18, 1844, from the "Dublin Journal"). The author's experiments do not confirm this opinion.

Vomiting should be encouraged by emetics. A mixture of iron filings and gold-dust has been recommended. By this means the mercury is said to be reduced. Supposing the antidote worth anything, it is not often likely to be at hand when wanted. If salivation is troublesome, gargles of alum, and chlorate of potash must be employed. The after treatment will depend on the symptoms, but white of egg in milk should be administered two or three times daily for some few weeks.

Chronic Mercurial Poisoning.

The symptoms of *chronic* poisoning known as *shaking palsy*, *mercurial tremors, &c.*, occurring in those engaged in handling mercurial compounds, or, in those exposed to the fumes of mercury, vary somewhat in detail, but are tolerably constant in their leading characteristics. The time when the symptoms set in, is as variable as their duration. They will probably commence by the person complaining of debility, nausea, and vomiting, with frequently recurring colicky pains, and a constant and disagreeable coppery taste in the mouth. It will be noticed, moreover, that the breath of the patient is fœtid, the breathing difficult, the act of swallowing an effort, whilst there may be a constant hacking cough with occasional spitting of blood. Sooner or later salivation or ptyalism will become the prominent symptom, the tongue and gums becoming red, swollen, and ulcerated. It must, however, be remembered that many things produce salivation besides mercury, and hence we must never be hasty in drawing conclusions from this symptom alone. Bromine ("Edinburgh Medical and Surgical Journal," July, 1842), arsenic ("London Medical Gazette," 16); antimony, lead (Christison, p. 514), prussic acid ("Medical and Physiological Journal," vol. 46, pp. 359 and 363), nux vomica ("London Medical Repository," 19, p. 448), as well as gold, cantharides, digitalis, conium, belladonna, opium, and particularly iodide of potassium, have all been known at times to produce salivation ("Lancet," Sept. 3, 1842, p. 807). Mercurial ptyalism, however, is peculiar in two respects, viz., the extreme fœtor of the breath, and the painful sponginess of the gums. If any question exists, however, as to the cause of the salivation, all doubt can be set at rest by examining the saliva, where, if it be due to mercury, the metal is sure to be discovered.

Not unfrequently has *cancrum oris* following some debilitating disease in ill-cared for children, been explained by parents as due to mercurial salivation; and as very possibly the doctor may have administered a dose of some preparation of mercury as a mild laxative, the charge may seem to the outside world to have some weight. A dark red line in chronic mercurial poisoning may often be observed in the gums, and sometimes also a blue line, not unlike that produced by the action of lead. This, however, is by no means a constant symptom. The teeth, too, according to Dr. Guy, are often very brittle.

Another well-marked symptom of chronic poisoning is the trembling and convulsive movements of the limbs (*mercurial tremors*), attacking in the first instance the upper extremities, then extending to the lower, walking thereby being rendered difficult. By leaving off work, and by active and appropriate treatment, such as great attention to cleanliness and the internal administration of white of egg, the patient may possibly recover, but on the other hand severe cases occur where death results from an intense exhaustion, accompanied by gangrene of the mouth and other severe symptoms.

In looking-glass manufactories, where it is common for the workpeople to suffer from symptoms of mercurial poisoning, Dr. Meyer recommends as an excellent prophylactic the sprinkling the workshop every evening freely with ammonia after the day's work is done ("Lancet," April 26, 1873, p. 601).

We may further notice that one case is recorded where metallic mercury was given, but without result, to produce abortion ("Lancet," March 8, 1873, p. 339), whilst mercurial tremors were produced by the action of the metal.

Experiments on Animals.

The experiments on animals are important and may be thus summarised :—

1. Six to twenty grains of corrosive sublimate inserted *into the stomach* of rabbits and cats, killed them in from five to twenty-five minutes, insensibility being produced in a few minutes, and afterwards convulsions (Orfila).
2. The local action of the poison on the living stomach is similar to its action when applied to the dead stomach, the tissue being rendered thereby grey and brittle.
3. When the chest was opened directly after death, the heart was found motionless or contracting but feebly, whilst the blood in the left side was arterial (Sir B. Brodie).
4. Doses of three, four, or five grains cause death, when applied *to a wound,* in from two to five days. Dysenteric symptoms usually occur, inflammation or even ulceration of the stomach and rectum being noticed after death. The lungs and the heart are generally inflamed (Orfila and Smith).
5. The inflammation of the lungs and the inflammation of the stomach and rectum is even more marked when the poison is *injected into the blood.* Death after this form of administration is sometimes very rapid (Gaspard).

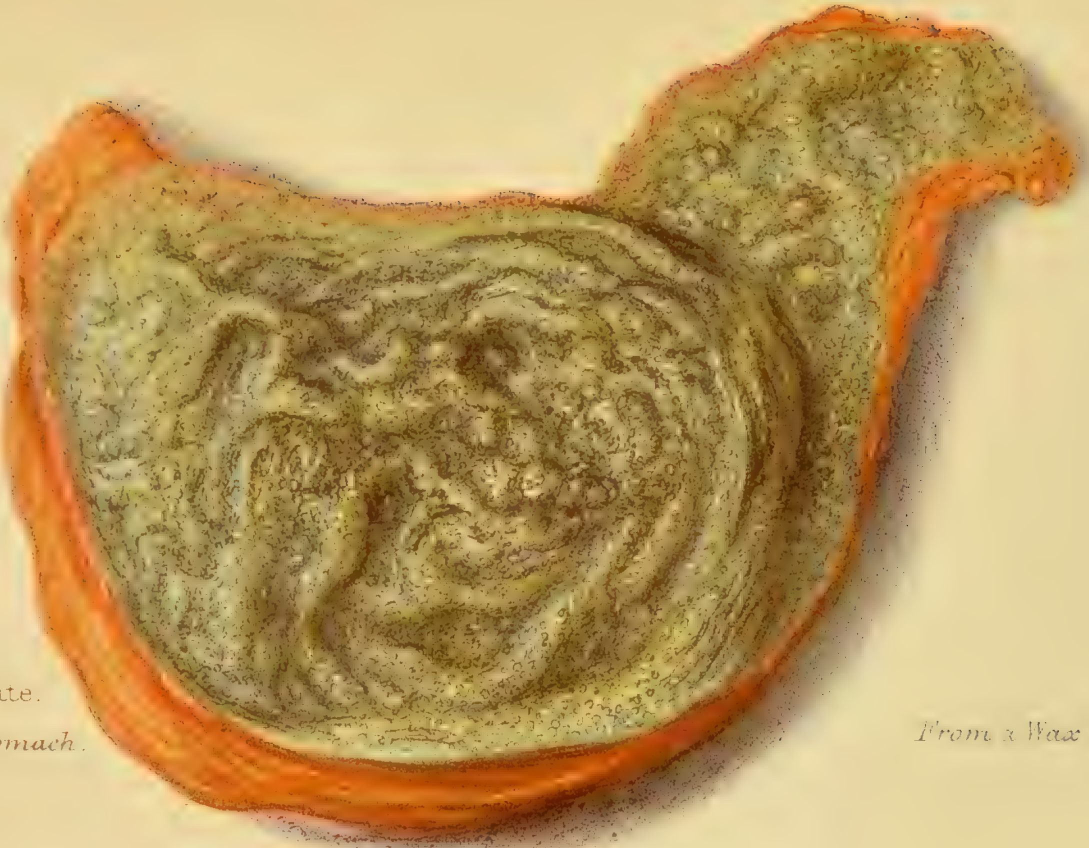
Post-Mortem Appearances.

The abdomen is generally very tympanitic. The salivary glands will be found enlarged, and saliva trickling from the mouth. The tongue is frequently shrivelled, the papillæ at the base being enlarged and very prominent.

The mucous membrane of the mouth and throat frequently has a greyish white appearance, whilst at other times it is found to be intensely inflamed and even corroded. Where there has been salivation, the parts may even be in a state of slough. The stomach is often covered with a slate-coloured precipitate of finely divided mercury (Plate II.), or if putrefaction has commenced, with a black deposit of the sulphide. Sometimes, however, it is intensely inflamed, the inflammation being greater than that found even in arsenical poisoning. Perforation is rare. The intestines generally are much congested, and so also are the whole urinary organs, the bladder being often empty and contracted.

Dr. Byasson has examined with great care the time it takes for a soluble mercurial salt, introduced into the stomach, to get into the urine, saliva, and sweat. Corrosive sublimate he found takes two hours to reach the urine, and four hours to reach the saliva. He never found it in the perspiration. Twenty-four hours after it has been taken he

Plate II.



Corrosive Sublimate.

P. M. Appearance of Stomach.

From a Wax Cast by D^r. Letheby.

T. Burgess del. et ch: lith.

W. West & Co. imp.

regards its elimination as complete ("Robin's Journal d'Anatomie et de Physiologie").

(See an extraordinary account of metallic mercury being found in the bones after death by corrosive sublimate, to such an extent that it was possible to shake out globules of the metal by striking the bone on the table; "Lancet," Sept. 20, 1873, p. 429).

Tests.

All the salts of mercury are volatile; they are all reduced when heated with protochloride of tin, and they all yield a sublimate of metallic mercury when heated in a glass tube with carbonate of soda.

1. With *proto-salts*, such as *calomel* ($Hg\,Cl$)—

(α) *Potash, soda,* or *lime,* give a black precipitate ($Hg_2\,O$).
(β) *Sulphuretted Hydrogen* or *sulphide of ammonium* give a black precipitate ($Hg_2\,S$).
(γ) *Hydrochloric Acid* gives a white precipitate ($Hg\,Cl$), which is turned black by ammonia.
(δ) *Iodide of Potassium* gives a greenish-yellow precipitate.
(ε) *Ferrocyanide of Potassium* gives a white gelatinous precipitate.

2. With *persalts,* such as *corrosive sublimate* ($Hg\,Cl_2$)—

(α) *Potash, soda,* or *lime,* give a bright yellow precipitate ($Hg\,O$).
(β) *Sulphuretted Hydrogen* gives first a white precipitate (especially marked in dilute solutions), rapidly changing to black, passing through shades of yellow, orange, and brownish red. *Sulphide of ammonium* gives a black precipitate.
(γ) *Hydrochloric Acid* gives no precipitate.
(δ) *Iodide of Potassium* gives a yellow precipitate, becoming red, and being soluble in excess.
(ε) *Ferrocyanide of Potassium* gives a white precipitate, becoming blue.

Tests for Corrosive Sublimate.

Our tests prove, as a rule, simply the existence of mercury. By careful search we may, in some cases, detect in the stomach and intestines, small undissolved pieces of corrosive sublimate. But this is not usual. It is well to remember, moreover, that mercury is a common medicine, and hence the necessity of guarded evidence, when a mere trace only is discoverable.

A. *Tests for solid corrosive sublimate.* Note—

(1) Its crystalline form under the microscope (figs. 21 and 22).

(2) If a small portion be heated on platinum foil it will be entirely dissipated, white fumes being given off.

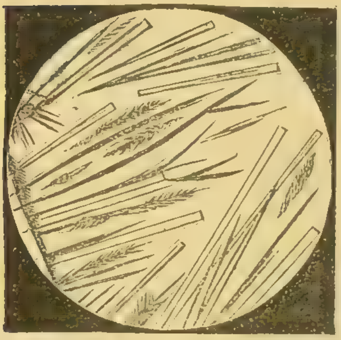
(3) Heated in a small tube, a characteristic crystalline sublimate may be obtained.

(4) Mix a small quantity of the salt in a dry clean reduction tube with four times its bulk of recently calcined carbonate of soda, covering the mixture over with a little additional carbonate. Heat the carbonate on the surface first with a spirit lamp, and after this is

thoroughly heated apply the heat to the mixture, when a globular sublimate of metallic mercury will be found to form in the cool part of the tube.

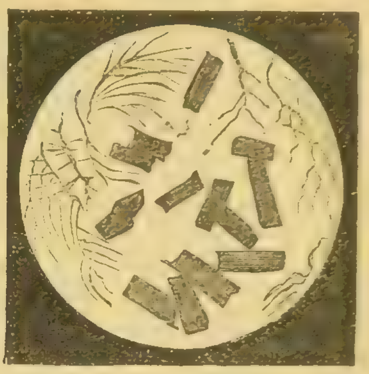
(5) Break off the portion of the tube containing the *fused residue*, boil it in a little water acidulated with nitric acid, and precipitate the chlorine with a solution of nitrate of silver. The chloride of silver is soluble in ammonia. (Memo.—Test your carbonate of soda previously, to prove that it contains no chloride.) The remaining tests are best applied to a solution of the poison.

FIG. 21.



Crystals of Corrosive Sublimate from an aqueous solution, magnified 80 diameters.

FIG. 22.



Crystals of Corrosive Sublimate from an alcoholic solution, magnified 80 diameters.

B. *Tests for Solution of Corrosive Sublimate.*

(1) *Iodide of potassium* gives a yellow precipitate, rapidly changing to a bright scarlet (Hg I_2), freely soluble in excess of iodide of potassium, and to an extent in solutions of alkaline chlorides. Collect and allow the red precipitate to dry without the application of heat.

(*a*) Heat a small portion on a piece of white paper, when the scarlet precipitate turns yellow, gradually changing back again to scarlet, if allowed to remain on the paper, or if rubbed with a knife.

(β) Heat a small portion, mixed with four times its bulk of carbonate of soda, in a reduction tube, when a sublimate of metallic mercury will be obtained in the cool part of the tube.

(2) *Sulphuretted hydrogen* produces, at first, a white turbidity, which rapidly changes, as above, to a densely black precipitate of the sulphide. *Sulphide of ammonium* produces the same black precipitate as the gas. The precipitate is insoluble in boiling nitric acid. Collect the precipitate on a filter paper, and dry.

(*a*) Heat a small quantity in a dry reduction tube, when it will be found to volatilize *completely*, a black sublimate being formed.

(β) Heated with carbonate of soda in a reduction tube, a metallic-sublimate will be produced.

(3) Excess of potash or lime water produces an orange yellow pre-

cipitate of the hydrated oxide, a re-action common to all the persalts of mercury. (A black precipitate is given with calomel.) Filter, examine the precipitate, and filtrate as follows :—

(α) Heat *the precipitate*, when oxygen will be given off, which may be collected in a test tube placed over water, and tested by its action on a glowing splinter. Reduced mercury will be found in the tube in which the precipitate was heated.

(β) *The filtrate* is to be acidulated with nitric acid, and tested for chlorine with nitrate of silver.

(4) *Protochloride of tin* (Magpie test). (The experiment is best conducted in a watch glass.) This gives with corrosive sublimate, acidulated with hydrochloric acid, first a white precipitate (calomel), afterwards becoming grey, and ultimately black, the black deposit being finely divided mercury. Apply heat to the mixture, pour off the supernatent liquid, and boil the precipitate with hydrochloric acid, when globules of metallic mercury will be obtained.

(Memo.—This test is interfered with when either alkaline chlorates or free nitric acid is present.)

(5) Acidulate a solution of corrosive sublimate with a sixth of its bulk of hydrochloric acid. Put into the solution a piece of bright copper foil. A silver coating of mercury will be after a time deposited on the copper even in the cold, the action being aided and rendered more rapid when heat is applied. Arsenic similarly treated will not be deposited at all on copper in the cold. Remove the copper slips, wash, and dry at a *very gentle* heat.

Place the slips of copper in a dry tube, and apply the heat of a spirit lamp. The copper will entirely lose its silver coating, whilst a sublimate of metallic mercury will form in the tube.

Note respecting this sublimate—

(α) It consists of perfect spheres that are opaque to light, and of a silvery white colour.

(β) They do not oxidize by successive resublimations.

(γ) Dissolve the sublimate in a few drops of a mixture of nitric and hydrochloric acids, heat on a sand bath to dryness, and touch the residue with iodide of potassium, when it will turn first yellow, afterwards changing to scarlet.

7. Acidulate a few drops of the solution of corrosive sublimate with hydrochloric acid ; place it on a piece of gold foil, or upon a sovereign. Touch the edge of the gold with a key or other steel instrument, allowing another portion of the key to touch the metal through the liquid, when mercury will be deposited on the gold as a bright silver stain where the two metals meet. This silver stain may be entirely dissipated by the application of heat.

Toxicological Analysis.

(A.) In conducting an enquiry in a case of suspected poisoning, mix the contents of the stomach, together with the tissues cut up and crushed in a mortar, with sufficient alcohol to render filtration easy. Acidulate them with hydrochloric acid, and gently warm for some time. Filter and test the filtrate both by Reinsch's test and by sulphuretted hydrogen. All the materials on the filter paper are then to be mixed with hydrochloric acid and water (one to four) boiled and filtered, the filtered liquid being then similarly examined by the process of Reinsch.

In this way we shall be able to prove the presence of *mercury*, but not of *corrosive sublimate*. Proof of this, however, may sometimes be obtained by concentrating the contents of the stomach by evaporation, and shaking them up with a large bulk of ether, in which corrosive sublimate is very soluble. The ether is to be carefully decanted, distilled off at a gentle heat, and the residue tested for the salt.

(B.) To detect mercury in the saliva (which is one great means of its elimination), acidulate about two drams of the saliva with hydrochloric acid, and put into the mixture a small piece of clean bright copper, and note whether it becomes covered with a silver deposit. The copper may then be gently heated in a reduction tube, and in this way the metal obtained and tested accordingly.

(C.) In examining the urine, evaporate down about fourteen ounces to one ounce. Acidulate this with hydrochloric acid, filter, and boil the filtrate with a piece of bright copper foil, and proceed as already directed.

(D.) In a case where arsenic and corrosive sublimate are mixed together, either the corrosive sublimate may be separated by agitation with ether in which corrosive sublimate is soluble and arsenic is not, or the arsenic may be distilled off as a chloride.

Cases have occurred where chemical analysis has failed to find the poison, after death from its exhibition. Dr. Byasson regards its elimination as usually complete even after twenty-four hours—whilst most experimenters agree that if a patient lives for fourteen days after the poison has been swallowed, there will be but little chance of finding it.

Quantitative Estimation.

Mercury is estimated quantitatively as a sulphide.

$$\begin{aligned} 100 \text{ grains } HgS &= 86{\cdot}2 \ Hg. \\ &= 116{\cdot}81 \ HgCl_2. \\ &= 101{\cdot}07 \ HgCl. \\ &= 108{\cdot}42 \ HgH_2NCl. \end{aligned}$$

Calomel. (Mercurous Chloride. Hg Cl.)

Calomel may destroy life, either by its powerful irritant action, or by causing gangrenous ulceration of the mouth and throat from the excessive salivation it produces. Twenty grains, and even a less quantity than this, has produced fatal results. Its action, as a poison and as a medicine, is curiously modified both by disease and idiosyncrasy. Nor must we forget the possibility that a trace of corrosive sublimate may be present in calomel, which at times is more than sufficient to explain its violent and unlooked-for action. Mr. Tosswill records cases of salivation being produced in one case by two and a half, and in a second case by five grains of calomel ("Lancet," September 4, 1841, p. 863). Dr. Munk records the case of a woman being salivated by one grain of calomel, all the family being equally susceptible to its influence ("Lancet," January 18, 1840, p. 626); whilst another case is on record where two grains produced salivation, exfoliation of the lower jaw, and death (" Lancet," November 25, 1837, p. 294). Further, it is recorded that salivation has been produced where calomel has simply been applied externally (" Lancet," 1850, vol. i., p. 195).

Calomel has been used for worm lozenges, and death been caused thereby (" Medical Times and Gazette," April 24, 1858, p. 431).

Calomel is a heavy white powder without taste or smell. It volatilizes at 115·0 Cent. as an amorphous powder. Unlike corrosive sublimate it is insoluble in water, alcohol, or ether. It is turned black by caustic potash, by ammonia, and by sulphide of ammonium. Proto-chloride of tin, as in the case of corrosive sublimate, turns it black, and if this be heated in a reduction tube with carbonate of soda, the metal will be reduced, and may be collected as a sublimate.

White Precipitate (Ammoniated Mercury; Ammonio-Chloride of Mercury, $NH_2 Hg''Cl$.)

A question has been raised whether this substance is a poison, but there can be very little doubt that it is so. Dr. Pavy's experiments have proved conclusively that it is far more powerful in its action than was once supposed. Four or five grains was found to kill a rabbit. The mercury after death was found specially deposited in the liver.

White precipitate is prepared by adding ammonia to a solution of corrosive sublimate, the precipitate being collected, washed, and dried.

It is a white amorphous heavy powder, insoluble in water, alcohol, or ether. Dr. Taylor says that the white precipitate of the shops frequently contains one or two per cent. of corrosive sublimate. Heated with a solution of potash, it gives off ammonia vapour which browns turmeric paper, the solution turning yellow from the formation of the oxide of mercury. It is soluble in acids. Heated with carbonate of soda, a metallic sublimate is formed. In conducting a toxicological investigation, the organic fluids and solids must be boiled in dilute hydrochloric acid, and filtered, when upon adding some pieces of bright copper to the filtrate, metallic mercury will be deposited.

Red Precipitate (Mercuric Oxide $Hg O$).

This is prepared by heating mercury exposed to the air to nearly its boiling point, when oxygen is absorbed, and the oxide formed on the surface of the metal.

It is used, mixed with grease, as a vermin killer. It is an active poison, but has seldom been used for criminal purposes.

It is usually found in the form of shining scales of a red colour. It is insoluble in water, but soluble in hydrochloric acid. Heated, it is resolved into oxygen and metallic mercury.

Turpeth or Turbeth Mineral (Mercuric Oxysulphate $Hg_3 O_2 SO_4$.)

One dram of this salt in one case proved fatal to a boy in seven days, and in another case forty grains proved fatal to an adult in eleven days. The symptoms produced were those of an irritant poison. It is a heavy yellow powder, soluble in 2000 parts of water. When heated, fumes of sulphurous acid are evolved, a sublimate of the metal being produced.

Mercuric sulphide (HgS).

This body is known as *vermilion* when in the form of powder, and *cinnabar* when in lumps. It has been used on account of its brilliant tint for colouring confectionery, wafers, &c., and also as a colouring matter for the vulcanized rubber which is largely employed in the manufacture of frames for artificial teeth. Its use for this purpose is very much to be deprecated ("British Medical Journal," September 5, 1863, and "Medical Press and Circular," December 9, 1874). One of the authors (Dr. Woodman) has shown (Transactions of Odontological Society of Great Britain) the serious results that may arise from its employment. The red vulcanite contains a quantity of vermilion, varying from 33 to 36 per cent. No doubt, as Orfila pointed out, large doses may be given to dogs, without poisoning symptoms being induced. From this he inferred that, as a poison, it was almost inert, a conclusion, however, which is quite at variance with the general experience of physicians, when it is administered in the form of vapour baths for syphilis. The poisonous action produced by it in the form of vulcanite teeth plates, may either be due to the formation of a small quantity of corrosive sublimate by the action of the chlorides of the saliva and of food, or to the escape of portions of the unmixed pigment from cracks or fissures in the plate, either in the solid form, or in the shape of vapour.

It may be known from *red lead* by its not being blackened with sulphide of ammonium and from *red precipitate* by its insolubility in hydrochloric acid.

It is a heavy substance, insoluble both in water and hydrochloric acid, and is entirely dissipated by heat. Heated with carbonate of soda in a tube, globules of mercury will be formed.

If present in organic liquids or solids, they must be acted on with nitro-hydrochloric acid, and evaporated to dryness. The corrosive sublimate thus formed must be dissolved in water or spirit, and tested accordingly.

Mercuric nitrate ($Hg\,2NO_3, 2H_2O$) and *mercurous nitrate* ($Hg\,NO_3, H_2O$.)

Both are solid white poisonous salts, and act as strong corrosives. They are soluble in water, the solutions having acid re-actions. They have been used as applications to the throat and to the neck of the uterus. A sublimate of the metal is formed when the salts are heated with carbonate of soda.

Mercuric Cyanide ($Hg\,Cy_2$).

Twenty grains of this salt has proved fatal. The crystals are white, heavy, and soluble in cold water. It is as poisonous as corrosive sublimate, and the symptoms produced by it are similar. Cyanogen gas, which burns with a rose-coloured flame, is given off when the salt is heated. If it be treated with hydrochloric acid in a retort, and heat applied, hydrocyanic acid will distil over, whilst the solution in the retort will give a black precipitate when treated with sulphuretted hydrogen.

Mercuric Sulphocyanide (Pharaoh's serpent).

A case of severe symptoms being produced from taking the salt (a Pharaoh's serpent) is recorded, but the patient recovered.

Mercuric Methide.

This is a colourless, heavy, inflammable liquid, having an ethereal smell and taste. It contains 87 per cent. of mercury. It boils at 93° C.

Cases of Poisoning by Mercury and its Preparations.

(I.) MERCURY.

1\.

"Lancet," Oct. 27, 1838, p. 215 (Mr. J. W. Potter). Female: æt. 19. 18 grains of blue pill.

Symptoms.—Intense salivation; death.	*Result.*—Death in ten days.	

2\.

"Lancet," March 8, 1873, p. 339 (Sir Duncan Gibb). Female: æt. 20. ʒiv given to produce abortion.

Symptoms.—Administered to the woman when three months pregnant. In a few days mercurial tremors set in—lasted until confinement; no salivation. The child at birth had the snuffles.	*Result.*—Recovery.	

3\.

"Medical Times and Gazette," May 2, 1863, p. 466. Female. Blue pill.

	Result.—Death.	

4\.

"British Medical Journal," Jan. 11, 1868, p. 43. Blue ointment. Numerous cases.

Symptoms.—One case died; salivation in 40 other cases.	*Result.*—Death in 1 case.	

(II.) BICHLORIDE OF MERCURY (CORROSIVE SUBLIMATE).

5\.

"Lancet," Dec. 13, 1845, p. 650 (Dr. Herapath). Male: adult. 3j.

Symptoms.—Vomiting in two minutes; diarrhœa in 15 minutes; ptyalism on the third day, coma and convulsions on the eighth, and death on the tenth.	*Result.*—Death on tenth day.	*Post-mortem.*—Stomach and intestines inflamed; cæcal extremity of ilium almost gangrenous; cæcum inflamed and gangrenous; rectum much inflamed; lungs congested.

6\.

"Lancet," Sept. 16, 1871, p. 413 (Dr. Meeres). Female: æt. 9. Applied for ringworm. One application.

Symptoms.—Salivation in two or three days.	*Result.*—Death.	

7\.

"Archiv. Gén. de Méd.," vol. ix., p. 463 (M. Devergie). Female. 3iij in solution.

Symptoms.—Pain, vomiting, and purging; lips and tongue white and shrivelled; diarrhœa.	*Result.*—Death in 23 hours.	

8.

"Medical Gazette," vol. viii., p. 616 (Dr. Venables). Dose?

Symptoms. — Pain, bloody vomiting, diarrhœa, and suppression of urine. No salivation.	*Result.*—Death in 8 days.	

9

"Lancet," May 6, 1848, p. 500 (Mr. Wade). Male: æt. 21. Over ʒj in solution.

Symptoms.—Mucous membrane of the mouth not affected. Vomiting set in almost immediately, the vomit being bloody; pain not increased by pressure. At the end of two days the man was much better. On the third day there was a sudden failure of the powers of respiration.	*Result.*—Death on third day.	*Post-mortem.*—Mouth and œsophagus healthy; cardiac end of stomach black and gangrenous; pyloric end healthy, excepting a few red patches; heart empty; blood fluid; respiratory organs very congested.

10.

"Medical Times and Gazette," Feb. 18, 1860, p. 162 (Dr. Coghlan). Male: æt. 19. 12 grains taken on empty stomach.

Symptoms.—Vomiting and retching in three minutes; purging in a quarter of an hour; salivation on the third day. Not much pain.	*Result.*— Recovery.	

11.

Orfila's "Toxicologie," vol. i., p. 263. Male. Alcoholic solution.

Symptoms.—Instant tightness in the throat and burning in the stomach; vomiting and purging; great pain; micturition difficult and urine scanty; breathing oppressed; tendency to doze; cramps. No salivation.	*Result.*—Recovery in 8 days.	

12.

"Journal de Chimie Médicale," 1842, p. 294 (Vautier). 16 grains.

Symptoms.—Pain; tremblings of arms and legs; vomiting. No salivation.	*Result.*—Recovery.	

13.

"Medical Times," June 15, 1844, p. 228. (From "Edinburgh Monthly Journal." Dr. Watson.)

Symptoms.—Patient lived seven days, but there was no real salivation.	*Result.*—Death on seventh day.	*Post-mortem.*—Effects of poison almost entirely confined to alimentary canal; œsophagus, stomach, ileum, colon, and particularly the rectum, were much congested; bladder also inflamed.

14.

"Guy's Hospital Reports," April, 1844, p. 24. Dose?

Symptoms.—Complete suppression of urine.	*Result.*—Death in 4 days.	

15.

Casper's "Wochenschrift," Jan. 10, 1846, p. 30 (Dr. Wegeler). Male: æt. 17. ʒiij.

Symptoms.—No urine secreted during the last three days; no pain in the abdomen on pressure.	*Result.*—Death on sixth day.	

16.

"American Journal of Medical Science," April, 1863, p. 340 (Dr. Johnston). Male. 80 grains taken in whiskey and water.

Symptoms.—Vomiting in ten minutes; (albumen, milk, gold-leaf, and iron given). No salivation.	*Result.*—Recovery in 8 days.	

17.

"Edinburgh Monthly Journal," Dec. 1851, p. 532 (Dr. Thomson). Male. ʒij.

	Result.—Death in 40 hours.	*Port-mortem.*—Mucous membrane of stomach, duodenum, upper part of the ileum, parts of the large intestines (especially the cæcum and sigmoid flexure of the colon) were of a bright red colour.

18.

"Medical Times and Gazette," Feb. 26, 1859, p. 210 (Mr. Roberts). Male: æt. 42. 30 grains mixed with ½ oz. of tincture of perchloride of iron.

Symptoms.—Symptoms began in a few minutes: burning pain from gullet to stomach. No salivation; no blood in the vomit or evacuations.	*Result.*—Death on twelfth day.	*Post-mortem.*—Stomach empty, softened and red, and, towards the intestines, pulpy and gangrenous; intestines intensely inflamed, almost gangrenous.

19.

"Edinburgh Monthly Journal," vol. i., 1860, p. 958. 60 to 80 grains.

Symptoms.—No symptoms on the first day; mouth and gums affected on the third day; on the eighth day was apparently well; and on the twelfth day died.	*Result.*—Death on twelfth day.	

20.

"Lancet," Feb. 1, 1862, p. 119 (Dr. Skegg). Male: æt. 54. 112 grains.

Symptoms.—Symptoms came on very soon: intense pain and bloody purging; mouth and tongue white; skin blanched; vomiting of a stringy substance.	*Result.*—Death in 3½ hours.	*Post-mortem.*—Stomach externally deep red, internally of a dark crimson colour; intestines reddened.

21.

Taylor's "Medical Jurisprudence," vol. i., p. 283. Male: æt. 25. 5 grains dissolved in vinegar.

Symptoms.—Immediate heat and vomiting; bloody stools and vomit; urine suppressed. Greater part of the poison was got rid of by vomiting.	*Result.*—Death in 6 days.	*Post-mortem.*—Mucous membrane of stomach reddened; no appearance of corrosion; small and large intestines deeply congested.

22.

"Lancet," Feb. 26, 1870, p. 302 (Dr. Eade). Male: æt. 49. Lump of corrosive sublimate weighing over ʒj, taken when drunk.

Symptoms.—Ejected from stomach in one hour. Ordinary symptoms, with suppression of urine, set in on the third day; salivation on the fifth day.	*Result.*—Death on eighth day.	*Post-mortem.*—Lungs highly congested; heart healthy and empty; upper third of the œsophagus in a sloughy condition; stomach greyish, with patches of redness; all the intestines congested; bladder empty.

23.

"British and Foreign Medico-Chirurgical Review," Oct. 1860, p. 380. Male: æt. 27. 50 grains.

Symptoms.—Symptoms commenced immediately.	*Result.*—Death on sixteenth day.	

See also the following cases of poisoning with Bichloride of Mercury:—

"British Medical Journal," Aug. 8, 1863, p. 163. Recovery after taking 40 grains. Gold-leaf and iron-filings administered.
" " Aug. 22, 1874, p. 259. Poisoning by minute doses.
Taylor's "Medical Jurisprudence," vol. i., p. 282. Three grains. Death.
" " " p. 283. Death in 30 minutes.
"Medical Gazette," vol. xlvi., p. 253. Death in 15 days. No mercury found after death.
"Provincial Medical Journal," Nov. 18, 1843, p. 126. No purging; urine secreted in small quantity.

(III.) AMMONIO-CHLORIDE OF MERCURY.

24.

"Lancet," Feb. 8, 1840, p. 737 (Dr. R. Williams). Female: adult. A pennyworth. (?)

Symptoms.—Symptoms not very severe. Stomach-pump used.	*Result.*—Recovery.	

25.

"Lancet," Oct. 14, 1871, p. 540 (Dr. Ogle). Female: adult. 30 to 40 grains.

Symptoms.—Pain at epigastrium, and for 24 hours twitching of the muscles of the left arm and leg.	*Result.*—Recovery.	

26.

Reg. *v.* Moore (Lewes, 1860). Taylor's "Medical Jurisprudence," p. 289. A woman administered it to her husband. Acquitted on the ground that it was *not* a poison.

27.

"Medical Times and Gazette," Dec. 19, 1863, p. 645 (Dr. Greenhow). Female: adult. Swallowed first a pennyworth of white precipitate, and then a pennyworth of sugar of lead.

Symptoms.—Vomiting and pain in half an hour; afterwards drowsiness. Salivation set in on the third day, with convulsive twitchings of limbs. Salivation ceased on the eighth day.	*Result.*—Recovery.	

28.

Reg. *v.* Hargreaves (Manchester, 1866). A girl attempted to poison her father.

29.

"Lancet," July 4, 1857, p. 9 (Mr. Giles). Female. About ʒss.

Symptoms.—Immediate pain and sickness; swelling of face; salivation.	*Result.*—Recovery in about a month.	

30.

Medical Times and Gazette," May 5, 1860, p. 444 (Mr. Short). Male: æt. 3 months. 20 grains.

	Result.—Death.	*Post-mortem.*—Congestion of mucous membrane of the œsophagus; stomach normal, except one patch of inflammation.

31.

"British Medical Journal," April 10, 1869, p. 329 (Dr. Graham). Male: æt. 35. About ʒij.

Symptoms.—Pain, vomiting, and diarrhœa; collapse after ten hours. At no time was there any blue line in the gums or was there salivation. Blood was passed freely from bowels.	*Result.*—Recovery.	

See also the following case of poisoning with White Precipitate:—

"Medical Times and Gazette," March 5, 1864, p, 250. Female: æt. 9. Death from the ointment applied to scalp to kill vermin.

(IV.) RED PRECIPITATE.

32.

Taylor's "Medical Jurisprudence," vol. i., p. 290. Female: æt. 22. A quantity. (?)

Symptoms.—Surface cold and clammy; narcotic stupor; occasional vomiting of red matters; pain and cramps in the lower extremities. After four days she was still under the influence of the mercury.		

33.

"Irish Hospital Gazette," Oct. 15, 1873 (Mr. Russell). Female: æt. 15. Half an ounce taken by mistake.

Symptoms,—No urgent symptoms until the following day, when her lips, gums, and mouth became sore and swollen, a distinct mercurial fetor issued from the breath, the patient complaining of headache and pain.	*Result.*—Recovery.	

(V.) TURPETH MINERAL.

34.

"Lancet," March 13, 1847, p. 285 (Dr. Letheby). Male: æt. 16. ℥j.

Symptoms,—Burning pain; sickness; diarrhœa; salivation on the third day. Never either lost his senses, or became comatose, or had convulsions.	*Result,*—Death in 7 days.	*Post-mortem.*—Lips and gums of a leaden blue; from mouth to anus the alimentary canal was red, and studded with livid petechial spots, these being especially marked on the cæcum; intestines contracted.

35.

Taylor's "Medical Jurisprudence," vol. i., p. 291. Male: æt. 27. ℈ij on empty stomach.

Symptoms.—Purging and vomiting in ten minutes; pain in abdomen. Symptoms for a time improved, but he died on the eleventh day.	*Result.*—Death on eleventh day.	*Post-mortem.*—Stomach and intestines inflamed and softened.

36.

"Medical Times and Gazette," Aug. 22, 1863, p. 195 (Mr. Lowndes). Male: æt. 28. ʒj of the powder taken in mistake for æthiops mineral.

Symptoms.—Immediate burning sensation in the throat; vomiting; purging; cramps. Slight salivation on the second day.	*Result.*—Recovery.	

(VI.) VERMILION.

37.

"Medical Times," Sept. 27, 1845, p. 17. Female. Vapour of ʒiij applied to cancerous breast.

Symptoms. — Salivation, fever, and œdematous state of the right arm after three fumigations.		

(VII.) NITRATES OF MERCURY.

38.

"British Medical Journal," Jan. 27, 1872, p. 113 (Dr. Hickenbotham). Female: æt. 30. ℥ss of a solution of mercury in nitric acid (dressing for sheep-rot).

Symptoms.—Immediate violent pains; faintness.	*Result.*—Death in 25 minutes.	*Post-mortem.*—Mouth white, gullet and stomach corrugated. In some places the mucous membrane was quite destroyed.

39.

"Medical Gazette," vol. vi., p. 329 (Dr. Bigsby). Male: æt. 16. A teaspoonful of mercury dissolved in strong nitric acid.

Symptoms. — Symptoms set in very soon: pain, purging, and colic; mucous vomiting.	*Result.*—Death in 2½ hours.	*Post-mortem.*—Stomach inflamed and corroded.

40.

"Guy's Hospital Reports," Oct., 1850, p. 206. Application to throat as an escharotic.

Symptoms. — Death immediate by asphyxia.	*Result.*—Death immediate.	

41.

"Edinburgh Monthly Journal," 1864, p. 168. Application to the skin as a liniment.

Symptoms.—Ordinary symptoms of mercurial poisoning; death on the ninth day.	*Result.*—Death on the ninth day.	*Post-mortem.*—Stomach and intestines inflamed, with patches of ecchymosis. Mercury found in the liver.

42.

Reg. *v.* E. Smith (Taylor's "Medical Jurisprudence," vol. i., p. 292). A girl accused of administering it to her mistress in camomile tea.

43.

Taylor's "Medical Jurisprudence," vol. i., p, 292 (Dr. Taylor). Male: æt. 32. Chronic poisoning from its use during a period of four years for packing furs, which were brushed over with the nitrate of mercury.

Symptoms.—After three years he lost power in his hands; salivation set in soon after he commenced the work. No mercury was found in the urine. Died 14 days after his admission to the hospital.	*Result.*—Death.	*Post-mortem.*—Brain and spinal cord healthy. Mercury found in brain, kidneys, and liver.

See also the following case of poisoning by the Nitrate:—

"British Medical Journal," May 10, 1873, p. 537; "Medical Gazette," vol. xlv., p. 1025. Chronic mercurial paralysis, produced from using a solution of mercuric nitrate for steeping wool preparatory to its undergoing the process of felling.

(VIII.) CYANIDE OF MERCURY.

44.

Orfila, "Toxicologie," vol. i., p. 735. 20 grains.

Symptoms. — Symptoms immediate: vomiting, salivation, suppression of urine, purging, and convulsions.	*Result.*—Death in 9 days.	*Post-mortem.*—Stomach and intestines very inflamed.

45.

"Christison," p. 427. 10 grains.

	Result.—Death in 9 days.	

46.

Virchow's "Archiv," vol. xxxi., p. 117.

	Result.—Recovery.	

(IX.) SULPHOCYANIDE OF MERCURY.

47.

"Union Méd.," vol. 110, p. 525, 1865. Male: æt. 19. Swallowed a whole Pharaoh's serpent.

Symptoms.—Pain; difficulty of swallowing; vomiting which gave some relief; shiverings and great weakness; (lime-water given).	*Result.*—Recovery.	

(X.) MERCURIC METHIDE.

48.

"St. Bartholomew's Hospital Reports," 1865, vol. i., p. 141 (Dr. Edwards). Engaged in preparation of mercuric methide.

Symptoms.—Impairment of sight was the first symptom noticed; numbness of hands, deafness, and mercurial fetor and swelling of gums; delirium; loss of power on left side.	*Result.*—Death.	*Post-mortem.*—Brain very congested and œdematous; kidneys congested.

49.

"St. Bartholomew's Hospital Reports," 1865, vol. i., p. 141 (Dr. Edwards). Male: æt. 23. Engaged in preparation of mercuric methide.

Symptoms.—Weakness, soreness of gums, dimness of sight, giddiness, nausea, and vomiting; deafness; lost sensation and power of motion; delirium.	*Result.*—Death.	

MOLYBDENUM. Mo = 92.

This is usually found as a sulphide, the ore much resembling black lead in appearance. It is a grey metal and oxidizes when heated in the air ($Mo\ O_3$.) Molybdic acid is used in the laboratory as a means of detecting traces of phosphoric acid.

It is a very feeble poison. Thirty grains of molybdate of ammonia was found to kill a rabbit in two hours. In dogs, however, it merely produces purging and vomiting, whilst even ten grains injected into the jugular vein will not prove fatal.

NICKEL. Ni = 59.

Nickel is largely used in the composition of German silver (copper, zinc, and nickel). Vomiting is freely induced in a dog by a dose of twenty grains of the sulphate, whilst ten grains injected into the jugular vein will destroy life instantly.

Tests.

1. *Sulphide of ammonium* gives a black precipitate (NiS.)
2. *Ammonia* gives a green precipitate ($Ni\ H_2\ O_2$) soluble in excess.
3. It gives a purple grey to the borax bead in the reducing flame, and a violet in the oxidizing flame of the blowpipe.

OSMIUM. Os = 199·.

Osmium is the least fusible of all the metals. It oxidizes in a current of air ($Os\ O_4$), the oxide having a pungent smell, and being freely soluble in water.

The oxide is said to be almost as active a poison as arsenic. One and a half grains administered by the mouth will kill a dog in a day, whilst half that quantity will prove fatal in one hour if injected into a vein. It seems to act as a pure irritant.

Several French investigators have noticed the deleterious action of osmic acid. Amongst these are M. Frémy, M. Sainte Claire Deville (who himself was seized with persistent nervous asthma under its influence), M. Debray (who suffered from some affection of the eyes caused by it), and M. Julien Clément (in whom it induced a peculiar cutaneous disease, which was found very difficult to cure.)

A case of supposed poisoning by osmic acid, is related by M. Raymond in " Le Progrès Médicale (27th June, 1874). A man aged thirty, worked for a short time in the laboratory of M. Sainte Claire Deville, being out of employment in his usual work (band box maker). Here he daily handled pieces of osmium, platinum, and iridium. In the process to which these were subjected, an osmiate of baryta was produced. This was treated with nitric acid, and the osmium precipitated with sulphide of ammonium.

The man up to the time of beginning this new occupation was perfectly well and healthy, nor was there any history of syphilis.

Shortly after commencing the work, he was taken ill, the first symptoms of which he complained being pains in the eyes. He slept heavily at night, and was much troubled with nightmares. After a short time an extensive eruption appeared on the surface of the fore-arm, as well as on the face, and on both sides of the hands.

Extreme indigestion, frequent diarrhœa (nine or ten times daily), the passage at each stool of a quantity of black blood (the patient having no piles) and violent headaches, were the prominent symptoms as the case progressed. Nausea but without vomiting, shiverings, extreme dyspnœa, and cough rapidly supervened. On his admission to the hospital, the one prominent symptom was the extreme difficulty in breathing, amounting almost to threatening asphyxia. The temperature was 40° C. (104° F.) The chest on examination revealed the existence of a general bronchitis, and on the left side a somewhat extensive pneumonia. The skin of the hands and fore-arm were sprinkled with large and small papules of a red and brown colour, whilst the urine contained a large amount of albumen.

The man died eight days after his admission to the hospital. The pneumonia increased in severity, the temperature continued at 104° F.; no apparent diminution taking place in the amount of albumen in the urine, whilst the weakness gradually became extreme.

At the post-mortem *the lungs* showed extensive evidence of pneumonia. In one lung there was a gangrenous cavern in course of formation. On examination with the microscope, pus globules were discovered in the pulmonary cells of both lungs. *The kidneys*, too, showed the pathological appearances indicating Bright's disease. In *the stomach* there was a considerable amount of inflammatory action along the greater curvature. The other organs were healthy. On chemical examination, however, of the several viscera, no trace of the poison, which was the supposed cause of the illness, was discovered.

M. Raymond, however, concludes by stating that the case, in his opinion, was one of unquestionable poisoning by osmic acid.

PALLADIUM. $Pd = 106{\cdot}5$.

This metal is found in platinum ores, and is nearly as infusible as platinum. It is remarkable for its power of absorbing hydrogen. It can be dissolved in nitric acid, when a brown solution is formed.

The chloride given internally is not more energetic in its action than the corresponding platinum salt, but it is far more intensely active when injected into a vein. Two-thirds of a grain has been found to kill a dog in a minute.

PLATINUM. $Pt = 198$. Sp. Gr. 21·5.

All the salts of platinum act as irritant poisons.

Twelve grains of the chloride ($Pt\,Cl_4$) given to a dog, killed it in the course of a day, whilst half that quantity will prove fatal when injected into a vein.

Tests.

(The $Pt\,Cl_4$ is the only convenient solution for testing.)

1. *Caustic potash and ammonia* give yellow precipitates.
2. *Sulphuretted hydrogen* gives a dark brown precipitate ($Pt\,S_2$), soluble in sulphide of ammonium. Before passing the H_2S through the solution, add to it an equal bulk of a solution of common salt.
3. *Boiled with carbonate of soda* and sugar, a precipitate of metallic platinum (platinum black) falls.
4. *A solution of chloride of ammonium* gives a yellow precipitate of the double chloride of platinum and ammonium ($Pt\,Cl_4$, $2\,NH_4\,Cl$.)

SILVER. $Ag = 108$.

Sp. Gr. 10·5.

Silver is sometimes found native, usually in the form of a sulphide, occasionally as a chloride, but never as an oxide. It is also found in many metallic ores, as in those of lead and copper. It is very malleable and ductile. Electro-plate consists of a coating of pure silver deposited on a white alloy by galvanic action. The purer the silver the easier it is found to tarnish, and hence the reason why electro-plate so soon loses its brilliancy. Silver itself is not a poison, and the only salt of importance medico-legally is the nitrate.

Silver Oxide	$Ag_2\,O$	$= 232.$
Silver Nitrate	$Ag\,NO_3$	$= 170.$
Silver Sulphate	$Ag_2\,SO_4$	$= 312.$
Silver Sulphide	$Ag_2\,S$	$= 248$
Silver Chloride	$Ag\,Cl$	$= 143{\cdot}5$

Nitrate of Silver. $Ag\,NO_3 = 170$.

(Lunar Caustic—Lapis Infernalis.)

Lunar Caustic is found in shops either in sticks or in crystals. It is prepared by dissolving silver in dilute nitric acid, evaporating the solution to dryness, and crystallizing out the salt. Its solution in water rapidly decomposes in the presence of organic matter, a black insoluble compound being formed. Hence its use for marking linen. The black stains may, to a great extent, be removed by potassium cyanide. It is largely used by photographers.

Experiments on Animals—Symptoms, &c.

Orfila's experiments on nitrate of silver prove, that when injected into the veins its action is energetic. Two grains killed a dog in six minutes, the difficulty of breathing being the prominent symptom. A third of a grain caused death in four and a half hours by tetanus. In both cases the blood in the heart was black, and the lungs gorged. Given internally, thirty-six grains killed a dog in thirty-six hours, no particular symptom being noted, but the after-death appearance of the stomach betokened a corrosive action, parts presenting an appearance similar to the eschars produced by the action of the caustic silver on the skin. Nitrate of silver must, therefore, be regarded as an irritant and corrosive poison.

The blueness of the skin produced by the action of nitrate of silver, proves it to be freely absorbed. This colour is due to the reduction of the metal, and its deposition on the surface of the true skin. For this action to take place, the drug must be taken for a very considerable time. It is given medicinally in chronic gastric affections and in some nervous affections (epilepsy, &c.) in doses varying from a quarter to half a grain.

But, although no discoloration of the body may be apparent, the absorption of the poison is manifest, even when but one dose has been taken, for Orfila has found it under such circumstances in the liver, spleen, urine, &c., whilst Panizza and Kramer have found it in the blood.

The *treatment* of poisoning with silver salts is obvious. Common salt or sal ammoniac in solution must be given freely. Vomiting must also be encouraged. White of egg should be administered.

Post-mortem Appearances.

In slow poisoning the body will be found of a blue tint. When death is rapid from a large dose, a blue line will sometimes be found round the gums, the stomach and intestines being either intensely red and inflamed, or white from the action of the caustic nitrate, or black from the decomposition of animal matters.

Tests.

1. Mixed with carbonate of soda, and heated on charcoal with the blowpipe, a hard white malleable metallic bead is produced, with no incrustation whatsoever.

2. *Sulphuretted hydrogen* gives a black precipitate ($Ag_2 S$) insoluble in sulphide of ammonium, but soluble in warm nitric acid.

3. *The caustic alkalies* give a brown precipitate ($Ag HO$) soluble in excess of ammonia, but not in potash or soda.

4. *Hydrochloric acid* and any *soluble chloride* give a white precipitate

(Ag Cl), which turns slate-coloured after exposure to the light, soluble in ammonia, in hyposulphite of soda, and in cyanide of potassium, but insoluble in boiling nitric acid. The chloride, when heated, becomes a horny mass.

(Note, there are three insoluble chlorides—

(α) Lead chloride ($Pb\,Cl_2$)—not acted on by ammonia.
(β) Mercurous chloride (Hg Cl)—turned black by ammonia.
(γ) Silver chloride (Ag Cl)—dissolved by ammonia.)

5. *Iodide and bromide of potassium* give yellow precipitates, which are not easily soluble in ammonia.

Quantitative Analysis.

Acidulate the solution of the silver with nitric acid, and precipitate with hydrochloric acid; filter, wash, and dry the chloride.

$$\begin{aligned}100 \text{ grains (Ag Cl)} &= 75{\cdot}47 \text{ Ag.}\\ &= 118{\cdot}46 \text{ Ag } NO_3.\end{aligned}$$

Toxicological Analysis.

Boil the contents of the stomach with bicarbonate of potash and filter. Boil the residue on the filter paper with nitro-hydrochloric acid, and again filter. Mix the filtrates together, and evaporate them to dryness, so as to char the organic matter. Re-dissolve the residue in dilute nitric acid, and saturate with ammonia; filter and precipitate the silver with hydrochloric acid in a solution again rendered acid with nitric acid.

Cases of Poisoning with Nitrate of Silver.

1. Taylor's "Medical Jurisprudence." vol. i., p. 319. Female: æt. 51. A mixture containing 50 grains of Nitrate of Silver, taken in divided doses.		
Symptoms.—Vomiting of a brownish-yellow fluid.	*Result.*—Death in 3 days.	*Post-mortem.*—Stomach and intestines inflamed; silver found in stomach and liver.
2. "British Medical Journal," May 20, 1871, p. 527 (Mr. Scattergood). Æt. 15 months. A stick of nitrate of silver, ¾ of an inch long, slipped down the throat.		
Symptoms. — Immediate vomiting; (common salt was administered); convulsions. Death in violent convulsions in 6 hours.	*Result.*—Death in 6 hours.	*Post-mortem in 25 hours.*—Two or three patches of corrosion in the œsophagus; mucous membrane of stomach pale, except one patch of corrosion of a brilliant white colour (Ag Cl); duodenum and part of jejunum similarly corroded; heart empty and contracted.
3. "Medicine Légale (Devergie)," vol. iii. (M. Pommarède). Male: æt. 21. 1 oz.		
Symptoms.—Insensibility; convulsive movements of upper limbs of the face; forcible closure of the jaw; dilatation and insensibility of the pupil; improved under treatment, but afterwards had a relapse; ultimately recovered.	*Result.*—Recovery.	

4. "British Medical Journal," May 27, 1871, p. 552 (Mr. Hart). Æt. 4. A piece of stick caustic slipped down the throat.		
Symptoms.—Immediate vomiting induced (milk treatment alone adopted).	*Result.*—Recovery.	

THALLIUM. Tl = 204. Sp. Gr. 11·85.

The detection of a splendid green line in the spectrum, led to the discovery of thallium by Crookes in 1861. The salts are said to be very poisonous, but before anything can be definitely stated as to their physiological action, we need far more numerous and more accurate experiments than are as yet recorded. From the circumstance that the salts are perfectly tasteless, and very soluble in water, some more information than we at present possess is much to be desired. 15·5 grains of the carbonate killed a rabbit in a few hours (Paulet); 75 grains of the sulphate killed two hens, six ducks, two puppies, and a middle-sized dog; 1·5 grain killed a puppy in forty hours (M. Lamy). The symptoms described are intense dyspnœa, abdominal pains, salivation, convulsions, and specially paralysis. Nothing is said about vomiting or purging, and no marked post-mortem appearances are recorded.

Mr. Crookes' experience, however, seems completely different to what has been observed by these investigators. He states that he has himself swallowed one or two grains of thallium salt without any effect, nor has the vapour (to which he has been so much exposed) proved injurious. Thallium is said to stain the hair, and to render the skin hard and yellow. (For experiments on thallium poisoning, by M. Lamy, see "British Medical Journal," September 26, 1863, p. 352.)

The detection of the peculiar green band by the spectroscope, at once supplies us with a test for its presence of extreme delicacy.

TIN. Sn = 118.

Sp. Gr. 7·30: melts at 228·C.

Tin is chiefly found in Cornwall as tin-stone ($Sn. O_2$). It is a soft, malleable, silver-white metal, and is largely used for coating sheet-iron (tin-plate), as well as in various alloys, such as bronze, bell-metal, pewter, solder, &c. The metal itself is not a poison.

The chlorides are the only compounds of interest medico-legally. Under the name of "Dyers' spirit," they are largely used in calico-printing; whilst what is called "Tin prepare liquor," is a stannate of sodium (Na_2 $Sn.$ O_3, 4 H_2 $O.$) The oxide of tin constitutes one ingredient of putty powder, which is used for polishing silver-plate, and for giving white opacity to enamels.

Stannous Oxide	$Sn O.$	= 134.
Stannic Oxide	$Sn O_2$	= 150.
Stannous Sulphide (brown) . . .	$Sn S.$	= 150.
Stannic Sulphide (yellow) (mosaic go (bronzing powder)	$Sn S_2$	= 182.
Stannous chloride	$Sn Cl_2$	= 189.
Stannic Chloride (spirit of Libavius) . . .		= 260.

Experiments on Animals.

The chlorides of tin are decomposed by nearly all animal fluids and vegetable infusions. They are active poisons. According to Orfila's experiments, from eighteen to twenty-four grains given internally to dogs, killed them in one, two, and three days, the symptoms produced being violent vomiting, and great general depression. Applied to a wound, he found that two drams caused sloughing of the part, and death in twelve days. But the action of the chloride is far more energetic when injected into the veins, six grains killing a dog in one minute. Two grains thus administered killed a dog in fifteen minutes (tetanus being a prominent symptom), and 0·5 grains in twelve hours, a curious cataleptic condition being induced. The poison was discovered in each case after death in the liver, spleen, and urine. The morbid appearances were those of an irritant poison. Orfila refers to a peculiar tanned appearance of the villous coat in the stomachs of the dogs.

The tin salts act as irritant poisons in the human subject. In the treatment of poisoning cases a solution of carbonate of ammonia is indicated, together with large quantities of milk and white of egg. Vomiting must be encouraged by emetics, and the stomach-pump used, if necessary, with great care, and only if the case be seen very soon.

Tests.

(A) *Stannous Salts* (*e.g.* Stannous Chloride. $Sn\,Cl_2$).

1. *Sulphuretted Hydrogen* gives a brown precipitate ($Sn\,S$). Collect the precipitate, and, whilst moist, add yellow sulphide of ammonium, when it will be converted into a persulphide ($Sn\,S_2$). If an acid be added to this, a yellow precipitate falls.
2. *Solutions of Fixed Alkalies* give a white precipitate ($Sn\,2\,HO$), soluble in excess. If the solution be boiled, some of the tin is reprecipitated as stannous oxide (black) ($Sn\,O$.)
3. *Corrosive Sublimate* gives a grey precipitate consisting of mercury, in a state of fine subdivision.
4. *Chloride of Gold* gives a purple precipitate (Purple of Cassius).

(B) *Stannic Salts* (*e.g.* Stannic Chloride. $Sn\,Cl_4$).

1. *Sulphuretted Hydrogen* gives a yellow precipitate ($Sn\,S_2$), soluble in ammonia, and in sulphide of ammonium, and precipitated therefrom, on the addition of an acid.
2. *Solutions of the Fixed Alkalies* give a white precipitate of stannic acid ($H_2\,Sn\,O_3$) soluble in excess of the alkali, but not reprecipitated on boiling, as happens with stannous salts.

When tin compounds are heated by the blow-pipe on charcoal with carbonate of soda, a white metallic globule is formed, which will be found to be malleable and soluble in hydrochloric acid, to which solution the various tests may be applied.

Toxicological Analysis.

With organic liquids and tissues all that is usually necessary is to boil them for some time in water, acidulated with hydrochloric acid, then to filter, and to test the filtrate.

Cases of Poisoning by Chloride of Tin.

1. Orfila, "Toxicologie Générale," 1843, ii., 5; Christison, p. 489. Given to several persons by the cook using it by mistake instead of salt.		
Symptoms.—None vomited; colicky pains and diarrhœa.	*Result.*—All recovered.	
2. "Medical Times," Oct. 9, 1841. ʒss of solution of chloride.		
Symptoms.—Vomiting; pain. Delirium on the third day.	*Result.*—Death on third day.	

TITANIUM ($Ti = 50$).

Has no action, so far as experiments have as yet been made, on animal life.

TUNGSTEN, WOLFRAM ($W = 184$).

So far as we know, tungsten is perfectly inert. One of the authors has given one ounce of tungstate of ammonia to a dog, but no effects were produced.

URANIUM ($U = 120·$). Sp. Gr. 18·4.

This is a steel-white metal. The uranium compounds are chiefly used for glass staining, the *uranous oxide* giving a black, and the *uranic oxide* a fine yellow to glass. It is also used in photography.

Vomiting is induced when a dose of from fifteen to sixty grains of the chloride is given to a dog, but nothing more. Three grains of the chloride injected into a vein proves instantly fatal. (Gmelin.)

ZINC ($Zn = 65.$) Sp. Gr. 7·0.

Zinc is never met with in an uncombined state in the inorganic world; whilst it does not exist at all, so far as we know, in the organic. It is found both in the form of a sulphide ($Zn\,S$, Blende), and carbonate ($Zn\,C\,O^3$, calamine). Zinc is a bluish-white metal, very brittle, and breaks with a crystalline fracture. At 100·C it is, to a certain extent, both malleable and ductile.

In moist air it rapidly tarnishes, a thin film of oxide being formed. It quickly dissolves in dilute hydrochloric and sulphuric acids, and also in a hot caustic potash solution, hydrogen being set free. Nitric acid acts on it powerfully, but the acid itself is decomposed. It boils at 1040·C., and at this temperature gives off a vapour, which burns with a bluish-white flame, depositing zinc oxide. The inhalation of zinc fumes are said to have produced injurious results. ("Chemical Gazette," viii. p. 362; and Christison, p. 502.) It is thought by some that the evil effects produced in copper workshops on melting days is due to the zinc mixed with the copper (bronze), rather than to the action of the copper. Zinc is not itself a poison, but all its salts are, although nothing like so energetic in their action as those of lead and copper.

Zinc is largely used for roofing houses. Sheet-iron, dipped into a bath of melted zinc, is commonly known as *galvanized iron*. *Brass* is an alloy of zinc with copper; *German silver* consists of brass whitened with nickel.

All the salts of zinc are colourless; and most of them are readily soluble in water. The oxide is closely allied to magnesia in its combinations.

The use of zinc for cooking utensils is not altogether without danger; nor, considering the extreme brittleness of the metal, is it to be recommended for the purpose. Water, if it contains either a free acid, or fatty matters, or a quantity of salt, has a slightly solutive action on zinc.

Zinc Oxide . . .	$Zn\,O = 81.$
Zinc Carbonate (Calamine)	$Zn\,CO_3 = 125.$
Zinc Chloride . . .	$Zn\,Cl_2 = 136.$
Zinc Sulphide (Blende) .	$Zn\,S = 97.$
Zinc Sulphate . .	$Zn\,SO_4,\ 7\,H_2\,O = 161 + 126.$
Zinc Acetate . .	$Zn\,(C_2\,H_3\,O_2)_2\ 2\,H_2\,O = 183 + 36.$

Zinc Oxide ($Zn\,O = 81$).

This is formed when zinc is burnt in air. The hydrated oxide ($Zn\,OH_2\,O$) is precipitated by the addition of caustic soda or potash from solutions of its salts. Oxide of zinc is used occasionally under the name of "*Zinc White*," as a paint, in the place of white lead, its advantage being that it is not blackened by sulphuretted hydrogen.

Carbonate of Zinc—Calamine ($Zn\,CO_3 = 125.$)

When soluble carbonates are added to a zinc solution, the precipitate formed is a mixture of the carbonate and oxide. It is soluble in carbonate of ammonia, but not in the carbonates of potash or soda.

Chloride of Zinc ($Zn\,Cl_2 = 136$).

This salt is soluble in water, alcohol, and ether. It is used by plumbers in soldering as a flux. Further, it possesses powerful antiseptic and deodorizing properties. The strong aqueous solution constitutes what is known as "Sir William Burnett's Disinfecting Fluid." The strength of this liquid varies from 205 to 230 grains of the salt per ounce.

It is, moreover, a powerful corrosive poison. Several cases are recorded where it has been swallowed accidentally, and with a fatal result. Applied externally, it is found to act as a powerful escharotic.

The chloride of zinc differs in its action from all other zinc salts by its rapidly coagulating action on liquid albumen, and on the delicate tissues of the body. Its action on the living body is twofold:—(1st) It is a caustic and an irritant, producing pain, and instant vomiting; and, (2ndly), it exerts a specific action on the motor or organic system of nerves; for after the poison has been taken, the pulse and breathing are accelerated, the voluntary muscles become paralyzed, the pupils dilate, coma supervenes, and death occurs without a struggle. The poison may be found in the tissues, urine, and blood. The heart is usually found fully distended, and the blood black and uncoagulated. (Dr. Letheby.)

Sulphide of Zinc ($ZnS = 97$).

The native sulphide is known as *Blende.* Sulphide of ammonium throws down from zinc solutions the hydrated sulphide (ZnS, H_2O).

Sulphate of Zinc ($ZnSO_4 + 7\ H_2O = 161 + 126$).

(White Vitriol, White Copperas.)

Sulphate of zinc is a white crystalline salt, and effloresces in dry air. It is soluble in two and a half parts of cold, and in less than its own weight of boiling water. It is decomposed by albumen and milk, the animal matters forming insoluble compounds with it. It has more than once been taken by mistake for sulphate of magnesia. At 100·C it gives up six of water, and at 210·C it gives up all its water of crystallization. If exposed to a bright red heat, a mere residue of oxide of zinc is left.

In small doses (gr. j—vj.) it acts as a nervine tonic, and is useful in chorea, epilepsy, &c. A much larger dose can be borne after a patient has taken it for some time. It is also used as an astringent in chronic discharges from mucous membranes. In large doses (gr. x—gr. xxx.) it is given as an emetic, its action not being accompanied with very much general depression. In ordinary cases of poisoning twenty grains of the sulphate may be safely given, for the purpose of producing vomiting.

Acetate of Zinc ($Zn(C_2H_3O_2)_2\ 2\ H_2O = 183 + 36$).

This salt is formed by dissolving carbonate of zinc in acetic acid. It is soluble in water, and is given as a tonic in 1 gr. doses, and as an emetic in 15 gr. doses.

Symptoms of Zinc Poisoning. Dose, &c.

In the act of swallowing the peculiar and disagreeably metallic taste of the poison will be complained of. The immediate vomiting of matters containing more or less blood, the severe abdominal pain, accompanied with purging, and the burning pain in the gullet, are the prominent symptoms of poisoning with the zinc salts. The pulse is generally very feeble, the body very cold, the countenance very anxious, but the intellect clear. On one occasion no vomiting seems to have been produced.

After chloride of zinc has been swallowed, the several membranes with which it comes into contact, owing to its terribly corrosive action, will be found destroyed, froth will probably issue from the mouth, and the patient lose both voice and sight. Its action, too, on the nervous system is generally very considerable. The patient may, moreover, apparently recover from the primary symptoms; but they often again recur, or induce death by secondary causes, such as stricture of the gullet, or pylorus, or by the chemical action of the poison on the lining membrane of the stomach.

As regards *the time of death*, it is to be remarked that this specially depends on whether vomiting and purging are early or late symptoms. One ounce of the sulphate, or 100 grains of the chloride, may be regarded as a poisonous dose. Great tolerance of zinc compounds, however, is brought about by use. Thus we read of two scruples of the acetate being given three times a day in a case of epilepsy.

Treatment.

The treatment of zinc poisoning is similar to that recommended in cases of poisoning by copper. In cases where chloride of zinc has been taken, carbonate of soda, with milk, white of egg, tea, and decoction of bark are indicated. Opium may be given to relieve pain.

Post-Mortem Appearances.

When the sulphate has been taken, inflammation of the intestinal tract is uniformly found. The brain and lungs are generally congested.

With the chloride the post-mortem appearances, reported by Dr. Letheby, are a peculiar whiteness, and opacity of the mucous membrane of the mouth and œsophagus ; and a hard, leathery state of the stomach, which is generally corrugated, contracted, opaque, and of a dark leaden colour, all parts having a very acid reaction. The lungs and kidneys are usually congested. The fluid in the stomach often has the appearance of curds-and-whey. In one case two perforations in the stomach were found.

Fatty changes in the various viscera have been more than once recorded.

Experiments on Animals.

Orfila found that dogs recovered after taking as much as seven or eight drams of the acetate, if the poison was not artificially retained in the stomach ; but that death generally occurred in about three days, if the gullet was tied, the inflammation in the stomach after death being well marked. Injected into the veins, forty-eight grains caused instant death ; whilst with even twenty-four grains, death occurred in three minutes. Orfila found the poison afterwards in the spleen, liver, and urine. Blake's experiments showed that some depression of the heart's action was produced when even three grains was injected into the veins, whilst an arrest of the heart's action occurred in eight seconds, when thirty grains was similarly injected.

In Pyl's memoirs a case is recorded, where the outward application of the sulphate of zinc to an eruption caused death in five hours, with vomiting, purging, and convulsions.

Tests.

1. *Sulphuretted Hydrogen* gives in neutral or alkaline solutions (but not in an acid solution) a white amorphous precipitate. Zinc is the only metal that gives a white precipitate with sulphuretted hydrogen. A

similar precipitate is produced with sulphide of ammonium. The precipitate thus formed is insoluble in caustic alkalies, or in acetic acid, but is soluble in the mineral acids, even when very dilute. The precipitation of the metal is aided by a slight heat.

2. *Caustic Alkalies* give a white precipitate ($Zn\ H_2\ O_2$), soluble in excess of the alkalies, and in free acids.

3. *Alkaline Carbonates* give a white precipitate, insoluble either in excess of the carbonates, or in the fixed alkalies, but soluble in all ammonia salts.

4. The separation of zinc from its solutions can be effected by placing the solution in a platinum capsule, and touching the platinum through the liquid with a piece of magnesium, when the metal will be deposited on the platinum.

5. Zinc salts, when heated on platinum foil, leave a fixed infusible residue, which, when hot, is yellow, and, when cold, is white. If the residue be warmed with nitrate of cobalt, and afterwards heated with the blow-pipe, the mass assumes a brilliant green colour.

6. Zinc salts, heated with carbonate of soda in the reducing flame of the blow-pipe, deposit an incrustation similar to the above, that is, yellow when hot, and white when cold.

7. *Ferrocyanide of Potassium* gives a white amorphous precipitate, insoluble in mineral acids, but soluble in fixed caustic alkalies.

8. *Ferricyanide of Potassium* gives a reddish brown precipitate, insoluble in mineral acids, but soluble in caustic alkalies.

9. *Oxalic Acid* gives a white crystalline precipitate, very soluble in the mineral acids.

Note.—That nearly all the tests give white precipitates.

Quantitative Estimation.

Zinc is usually estimated quantitatively as an oxide. The solution must be boiled, treated with carbonate of soda until a precipitate ceases to be produced, again boiled, filtered, and the precipitate washed, dried, and ignited.

100 grs. $Zn\ O$ = 354·13 $Zn\ SO_4,\ 7\ H_2\ O$.
" " = 167·77 $Zn\ Cl_2$.
" " = 270·37 Acetate of Zinc.

Toxicological Analysis.

In examining the stomach and its contents, in a case of suspected poisoning, it should always be remembered that zinc may have been given to a patient as an emetic, and hence, although found in the stomach after death, not be the cause of death. If found, it should never deter us from seeking for other poisons.

Boil the contents of the stomach, or any organic liquid, with acetic acid. This will dissolve any zinc oxides existing in combination with animal matters. Filter the liquid, and pass sulphuretted hydrogen through the filtrate. Collect the precipitate, wash and dry. Act upon this with strong nitric acid, and dilute sufficiently with water. The solution may then be neutralized with carbonate of ammonia, and tested accordingly.

The presence of iron as a peroxide somewhat interferes with the reactions. The iron can be precipitated by first adding an excess of ammonia, and filtering the zinc remaining in solution. The filtrate must be evaporated to dryness; and a drop of acetic acid having been added to the residue, the zinc may then be dissolved in water and tested.

The solid matters must be incinerated, and the ash tested accordingly.

Cases of Poisoning with the Salts of Zinc.

(I.) CHLORIDE OF ZINC.

1.

"Lancet," Sept. 3, 1864, p. 267 (Mr. Crossing). Female: æt. 63. ℥iss. of Sir William Burnett's solution.

Symptoms.—Instant pain and vomiting, and afterwards purging. In 1½ hours the voice was gone, and she became giddy. In a few hours she had convulsions, with twitchings of the facial muscles; collapse, and death in 14 hours.	*Result.*—Death in 14 hours.	*Post-mortem.*—Body was preserved unusually well; mucous membrane of lips and tongue abraded, and that of the œsophagus and stomach entirely destroyed. No ulceration or perforation; duodenum and intestines congested; heart normal, left side gorged with blood; lungs congested.

2.

"Lancet," Jan. 9, 1864, p. 35 (Dr. Wardell). Female: æt. 21. ¾ of a wineglassful of Burnett's Disinfecting Fluid = 150 grains of Zn Cl_2.

Symptoms.—Violent and immediate vomiting, with great pain in stomach; pupils small; great prostration, but no paralysis of the upper or lower extremities.	*Result.*—Death in 41 hours.	

3.

"Edinburgh Medical and Surgical Journal," Oct., 1848 (Dr. Stratton). Female: adult. ℥ij of a solution = 12 grains.

Symptoms.—Pain; vomiting.	*Result.*—Recovery.	

4.

"Lancet," Sept. 12, 1857, p. 271 (Dr. Rose). Male: æt. 21. ½ pint of Sir William Burnett's Disinfecting Solution.

	Result.—Death.	*Post-mortem.*—Hands clenched; mucous membrane of stomach deep purple, partially corroded and destroyed; pyloric orifice constricted; duodenum much congested; right lung much congested; ventricles of heart filled with dark coagula; brain and membranes congested.

5.

"Lancet," Jan. 12, 1861, p. 29 (Dr. H. G. Wright). Female: æt. 7. ℥iss of Sir William Burnett's solution taken on an empty stomach.

Symptoms.—Symptoms immediate. She got better under treatment, and remained so for 10 days, when without any apparent cause vomiting of blood took place. From this time she became very ill, but recovered after a long illness. (Baths of milk were used).	*Result.*—Recovery.	

6.

"Lancet," Jan. 12, 1861, p. 30 (Dr. H. G. Wright). Female: æt. 13. Sir William Burnett's Fluid drank by mistake.

Symptoms.—She rallied for 2 days, after which hœmatemesis occurred, and violent sickness. She got better for a time, but died after a short period. There were no nervous symptoms.	*Result.*—Death after a few days.	

7.

"Edinburgh Medical and Surgical Journal," Oct., 1848, p. 335. Male: adult. Dose 200 grains.

Symptoms.—Burning pain; vomiting.	*Result.*—Recovery in 16 days.	

8.

"Lancet," Aug. 20, 1853, p. 159 (Dr. R. Hassell). Male. ℥iij of Burnett's Fluid.

Symptoms.—Incessant vomiting; purging set in on the third day; no corrosive action; nervous symptoms, indicated by perversion of taste and smell, set in.	*Result.*—Recovery in 3 months.	

9.

"Medical Times and Gazette," June 11, 1859, p. 595 (Dr. Markham). Female: æt. 46. 100 grains = half a wineglassful of solution.

Symptoms.—Vomiting and pain; apparently got well, but in 3 weeks the vomiting returned, accompanied with exhaustion.	*Result.*—Death in 10 weeks.	*Post-mortem.*—Stomach very constricted at intestinal end, so as only to admit a crow-quill.

10.

"Lancet," July 6, 1850, p. 23 (Dr. Letheby). Female: æt. 15 months. Sir William Burnett's Fluid.

Symptoms.—Extreme prostration, and died *comatose.* Occasional vomiting of a frothy fluid.	*Result.*—Death in 10 hours.	*Post-mortem.*—Lining membrane of the mouth and throat white and opaque; stomach hard and leathery, the inner surface dark-coloured; lungs and kidneys congested.

11.

"American Journal of Medical Science," Jan., 1860, p. 190. Female: æt. 40. A quantity of Disinfecting Fluid taken for Gin.

Symptoms.—Vomited in 10 minutes. Stomach became so irritable that food could not be retained.	*Result.*—Death in 14 weeks.	

12.

"British Medical Journal," September 5, 1874, p. 297 (Dr. Tuckwell). Female: æt. 21. A quantity (about 4 ozs).

Symptoms.—No injury to lips or to mucous membrane of the mouth; immediate pain and vomiting. For 57 days life was supported by injections. The body was full of petechial spots.	*Result.*—Death in 116 days.	*Post-mortem.*—Body much emaciated; fatty changes had taken place in various organs. Intestines very congested.

13.

"Lancet," Sept. 6, 1854, p. 259 (Dr. Thorn). Male: æt. 20 months. A teaspoonful of Crewe's Disinfecting Fluid.

Symptoms.—Great pain, purging, and vomiting.	*Result.*—Recovery.	

14.

"Medical Times and Gazette," Oct. 11, 1851, p. 382 (Mr. Milton). Male: adult. Burnett's Fluid taken for Gin. Drank a glass without noticing the mistake.

Symptoms.—Pain and vomiting soon set in; could scarcely move because of the agony it caused. He recovered after a week, but had a relapse, from which he recovered after three weeks.	*Result.*—Recovery.	

15.

"Medical Times and Gazette," Nov. 8, 1851, p. 497 (Dr. T. Ogier Ward). Female: æt. 40. About a mouthful, swallowed by mistake for vinegar.

Symptoms.—Burning pain; giddiness; loss of sight; purging and vomiting, collapse; loss of sensibility and loss of voice. Recovery after five weeks.	*Result.*—Recovery.	

16.

"Medical Times and Gazette," July 19, 1856, p. 59 (Dr. F. C. Webb). Male. ℥j of Burnett's Fluid by mistake, taken after a full meal.

Symptoms.—Great pain; constant vomiting; marked prostration; no signs of corrosion in either mouth or fauces. (Emetic administered very soon.) Recovery after many weeks.	*Result.*—Recovery.	

17.

"Medical Times and Gazette," Nov. 26, 1859, p. 525 (Dr. Habershon). Female: æt. 37. ¾ of a wineglassful of Burnett's Fluid.

Symptoms.—Vomiting in a quarter of an hour, afterwards purging; no blood, and an entire absence of pain. Three months afterwards pain set in, and eight days after this the patient died.	*Result.*—Death in 3 or 4 months.	*Post-mortem.* – Œsophagus and stomach ulcerated, perforation at the cardiac end; mucous membrane much destroyed.

18.

"Medical Times and Gazette," Oct. 18, 1862, p. 404 (Dr. Cousins). Female. About ʒij of Sir William Burnett's Disinfecting Fluid.

Symptoms.—In ten minutes great pain, nausea, and constriction of the throat set in; in five hours giddiness and loss of sight occurred; afterwards collapse. Death.	*Result.*—Death in 7½ hours.	

19.

'Medical Times and Gazette," Aug. 13, 1864, p. 188. Female. Chloride of zinc (soldering fluid.)

Symptoms.—Burning pain in throat and stomach.	*Result.*—Recovery.	

See also the following Cases of Poisoning by Chloride of Zinc.

"Medical Times and Gazette," June 6, 1863, p. 591 (Death).
"Medical Times and Gazette," July 4, 1863, p. 25.
"Pharmaceutical Journal," Jan. 1867, p. 420.
"Lancet," 1864, vol. I., p. 35.

(II.) SULPHATE OF ZINC.

20.

"Ann. d'Hyg.," 1871, vol. ii., p. 341. Female: æt. 60. Quantity? administered in soup.

Symptoms.—Those of irritant poisoning.	*Result.*—Death in 3 days.	*Post-mortem.*—Zinc found in spleen, liver, stomach, and intestines.

<table>
<tr><td colspan="3">21.
Taylor's "Medical Jurisprudence," p. 316 (Dr. Mackintosh). Male: æt. 20. ℥j</td></tr>
<tr><td><i>Symptoms.</i>—Early vomiting and purging.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">22.
"British and Foreign Medical and Chirurgical Review," April, 1849. Female: æt. 25. ʒiss taken for sulphate of magnesia.</td></tr>
<tr><td><i>Symptoms.</i> — Vomiting and purging immediate.</td><td><i>Result.</i>—Death in 13½ hours.</td><td></td></tr>
<tr><td colspan="3">23.
"British and Foreign Medical and Chirurgical Review," April, 1849. Female: æt. 35. ℥iss taken for sulphate of magnesia.</td></tr>
<tr><td><i>Symptoms.</i>—No vomiting for 15 minutes, or purging for half-an-hour. ;</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">24.
"Chemical News," June 16, 1865, p. 288 (Dr. Herapath). Slow poisoning by sulphates of zinc and iron.</td></tr>
<tr><td><i>Symptoms.</i>—Thirst, nausea, vomiting, heat in stomach and gullet.</td><td><i>Result.</i>—Death.</td><td><i>Post-mortem.</i>—Stomach inflamed.</td></tr>
<tr><td colspan="3">25.
Orfila's "Toxologie," vol. i., p. 573. Female. ℥ij by mistake.</td></tr>
<tr><td><i>Symptoms.</i>—Pain and vomiting. (Potash given in syrup.)</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">26.
Christison, p. 504. Child. Sulphate of zinc, used as wash to head.</td></tr>
<tr><td><i>Symptoms.</i>—Vomiting, purging, convulsions.</td><td><i>Result.</i>—Death in 5 hours.</td><td></td></tr>
<tr><td colspan="3">27.
"Medical Times and Gazette," Sept. 6, 1862, p. 252 (Mr. Marsh). Male: æt. 52. About ½ oz. of sulphate of zinc in solution.</td></tr>
<tr><td><i>Symptoms.</i>—Immediate pain and sickness. Seemed to be getting better during three days, when he had a relapse, and died.</td><td><i>Result.</i>—Death on the fifth day.</td><td><i>Post-mortem.</i>—All the tissues of abdomen loaded with fat; duodenum and stomach inflamed; heart fatty.</td></tr>
<tr><td colspan="3">28.
"Lancet," July 21, 1855, p. 52 (Dr. Brennan). Male: æt. 19. ʒiv in water by mistake.</td></tr>
<tr><td><i>Symptoms.</i> — Symptoms immediate: vomiting, purging, convulsions. (Magnesia administered.) Recovery in 3 days.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">29.
"Lancet," May 17, 1856, p. 540 (Dr. G. D. Gibb). Female: æt. 22. 67 grains.</td></tr>
<tr><td><i>Symptoms.</i>—Immediate bitter taste; great thirst and depression.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">"Lancet," May 25, 1872, p. 717. Male: æt. 21. ʒj of sulphate of zinc.</td></tr>
<tr><td><i>Symptoms.</i>—Vomiting and purging in a few minutes; cramp; pain in region of bladder.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
</table>

See also the following Cases of Poisoning with Sulphate of Zinc.

"Ann. d'Hyg.," vol. xxxvii., p. 329 (Tardieu and Roussin—Death).
"Medical Times and Gazette," July 16, 1853, p. 78.
"Lancet," August 27, 1859, p. 210 (Dr. Ogle).

CHAPTER XI.

THE MINERAL ACIDS.

SULPHURIC ACID—Preparation—Nuisances arising from oil of vitriol factories—Impurities—Method of purifying—Varieties of acids—Specific gravities of acids of various strengths (table)—Properties—Its action on various inorganic and organic bodies—Symptoms—Treatment—Post-mortem appearances—Tests—Methods of distinguishing free acid from acid in combination—Toxicological analysis—Acid stains—Quantitative estimation—List of cases—*Nitric acid*—Preparation—Varieties—Impurities—Method of purifying—Specific gravities of various strengths (table)—Action on (α) vegetable and (β) animal substances—Symptoms—Post-mortem appearances—Quantitative estimation—Toxicological analysis—Stains on clothing—List of cases—*Hydrochloric Acid*—Preparation of the gas—Properties—Action on animal life—Nuisances arising from the escape of the gas—Liquid acid—Specific gravities of acids of different strengths (table)—Properties—Impurities—Preparation of pure acid—Symptoms—Tests—Quantitative estimation—Toxicological analysis—Acid stains on clothing—List of cases—*Hydrofluoric Acid*—Preparation—Action and Tests.—*Nitro-sulphuric Acid*—Properties—Action on organic bodies—Tests.—*Nitro-hydrochloric Acid*—Properties and tests—*Sulphindigotic Acid.*

Sulphuric, Nitric, and Hydrochloric Acids.

These acids are of very considerable importance medico-legally. Being common trade articles, they are accessible to all, and procurable by all, without suspicion. The cases of poisoning, however, by them in England have been almost, without exception, accidental or suicidal. In Berlin, according to Dr. Caspar ("Medical Times," Aug., 1851, p. 213), nine-tenths of the cases of poisoning are effected by common oil of vitriol. The mineral acids, moreover, are not unfrequently employed by the mischievous and ill-disposed for throwing over dresses and clothes, and thus effecting their destruction.

SULPHURIC ACID (H_2SO_4, or H_2O, SO_3).

(Di-Hydric Sulphate—Oil of Vitriol—Vitriol—Spirit or Essence of Vitriol.)

Preparation.

Sulphuric Acid is prepared—

(1) By passing sulphurous acid gas (SO_2), vapours of nitric acid (HNO_3), steam (H_2O), and air into a leaden chamber, so arranged as to allow their free and perfect admixture. A shallow layer of water covers the bottom of the chamber.

> The *Sulphurous Acid* is produced either by burning crude sulphur or pyrites (which contains from 30 to 35 per cent. of sulphur), or the spent oxide from gas-works (which usually contains 40 to 60 per cent. of sulphur).

The *Nitric Acid* is obtained from nitre ($K N O_3$) by the addition of sulphuric acid ($H_2 S O_4$).

The *Steam* ($H_2 O$) is derived from a special water-boiler.

The *Air* in due quantity is obtained by providing a constant draught through the leaden chamber.

The following are the reactions that occur :—

(α) The $S O_2$ becomes oxidised at the expense of the oxygen of the nitric acid, which is by this means reduced to nitric oxide ($N O$).

$$3 (S O_2) + 2 (H N O_3) + 2 (H_2 O) = 3 (H_2 S O_4) + 2 (N O).$$

(β) The $N O$ thus formed instantly combines with the oxygen of the air, and nitric peroxide is formed ($N_2 O_4$).

$$2 (N O) + O_2 = N_2 O_4.$$

(γ) The $S O_2$ is now oxidised at the expense of the $N_2 O_4$.

$$S O_2 + H_2 O + N O_2 = NO + H_2 S O_4.$$

Nitrogen and nitric oxide only escape by the flue.

The dilute acid (chamber acid) which is formed at the bottom of the chamber, is drawn off, and duly concentrated.

(2) Sulphuric acid is also prepared by the distillation of dried sulphate of iron ($Fe S O_4$). This process is adopted at Nordhausen. Ferric oxide, which is a red powder, and known as colcothar ($Fe_2 O_3$) is left in the retort.

$$4 Fe S O_4 + H_2 O = H_2 O, 2 S O_3 + 2 Fe_2 O_3 + 2 S O_2.$$

Nuisances arising from Oil of Vitriol Factories.

And here we may note that nuisances arising from oil of vitriol factories are frequently a cause of nuisance, and form a subject of litigation. It will be seen that a free current of air through the leaden chamber is necessary for carrying on the process of manufacture; and as this current escapes at the exit pipe, it is not unlikely to carry with it various injurious gases. As a rule in practice, 100 parts of sulphur produce 200 to 294 parts of sulphuric acid ($H_2 S O_4$). Theoretically, 100 parts should produce 306·25 parts of the acid. The nitre also employed at the works ought not to exceed two parts by weight for every one hundred parts of sulphur; but, in reality, it is rarely less than four parts, and ranges from this to twelve parts, or more. Where the spent oxide is employed as a source of sulphurous acid, the amount of nitre used is rarely less than 7 per cent. If, then, we find any large disproportion between the materials used and the acid obtained, there is strong evidence that a considerable escape of gaseous bodies must be going on. This escape may be still more accurately estimated by direct experiment, as by abstracting the gases from the flues connecting the chamber with the general shaft. Dr. Roscoe states that in well-managed works the sulphur present should not exceed one grain per cubic foot. The air of the chimney-shaft, according to Dr. Letheby, should not contain more than 0·25 grain of sulphur per cubic foot, one-half of this amount being probably derived from the coal or coke used in the furnaces. The following are the main points to be observed in the inspection of oil of vitriol factories :—

(1) That the sulphur furnaces are burning properly—no fumes escaping therefrom.

(2) That the leaden chamber and flues are perfectly sound and air-tight.

(3) That the gases in the flues leading from the leaden chamber do not contain more than one grain of sulphur per cubic foot.

(4) That previously to the gases from the leaden chamber passing into the chimney-shaft, they are first passed through a water-scrubber (to take up sulphurous acid); then through a sulphuric acid scrubber (to absorb the oxides of nitrogen); and, lastly, through a lime purifier.

(5) That the process adopted in the concentration of the acid is similarly conducted, in order to prevent the escape of offensive gases.

Impurities.

The impurities and means of purifying sulphuric acid are important, and must be considered in some detail, as they often become subjects of question in law courts.

(1) *Compounds of Oxygen and Nitrogen*, derived from the nitric acid used in the manufacture.

These nitrogen compounds may be known in the acid—

(*a*) By its turning sulphate of iron an olive-green or black colour, the depth of colour varying according to the amount of the oxides present. To make the experiment, take a dram of the acid, mix it with a few drops of water, and allow the mixture to cool. Add to this, carefully, about half a dram of a saturated solution of green sulphate of iron, so that the solution may float on the acid. Note if any change of colour occurs at the spot where the two solutions meet, which will be at once produced if nitrogen compounds are present in the acid.

(*β*) By the acid bleaching a few drops of a dilute solution of indigo.

(*γ*) By its turning a red tint when mixed with a little brucia, the acid having been first diluted with its own bulk of water.

An acid that contains a very large quantity of nitrogen compounds is not well suited for generating sulphuretted or arseniuretted hydrogen.

(2) *Sulphurous Acid.*

(*a*) This is a frequent impurity of the acid, and renders it unfit for use in testing for metals by Marsh's process. If such an acid be used for generating hydrogen, the gas set free, although perfectly free from arsenic, is likely to baffle the skill of the unwary by blackening a solution of nitrate of silver when passed through it, and by depositing a yellow ring when heat is applied as the gas traverses a glass tube. These reactions are due to the development of sulphuretted hydrogen, the sulphurous acid being decomposed when present where hydrogen is being liberated. This test, however, enables us to discover the impurity. Or, again—

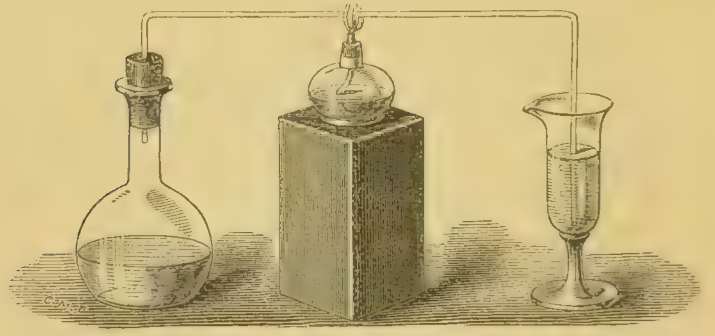
(*β*) Mix two drams of the acid with a few drops of water; add to this a dram of an acid solution of protochloride of tin, and immediately cover the mixture over with a piece of paper moistened at one spot with a solution of acetate of lead. If the paper be darkened, it is a proof of the presence of sulphurous acid in the original liquid.

(3) *Arsenic*, derived from the pyrites used in the manufacture. Dr. Letheby has found as much as 10 per cent. of metallic arsenic in some Cornish specimens of pyrites. The quantity of arsenic present in the acid varies greatly. Mr. Scanlan has procured 1·5 grains of the sulphide from 1000 grains of the acid ; Dr. Rees, 22 grains from one pint ; Mr. Watts, 30 grains from one pint ; and Hellman, 0·7 grain from one ounce. Arsenic, of course, is not present when the acid is prepared from native sulphur. Dupasquier states that the arsenic always exists in oil of vitriol in the form of arsenic acid (?).

To detect Arsenic in Sulphuric Acid.

(*α*) Neutralise the acid with carbonate of potash. Add to the mixture a little pure hydrochloric acid, and pass sulphuretted hydrogen through the solution. The yellow sulphide formed, if arsenic be present, is soluble in ammonia.

FIG. 23.



(*β*) Mix three or four drams of the acid with two or three drops of nitric acid, and heat. Dilute with water to a specific gravity of 1100. Pour this dilute acid into a flask containing a little pure granulated zinc, and pass the gas generated through a solution of nitrate of silver (fig. 23). If this be blackened, it may be due either to the presence of arsenic or of sulphurous acid. Now make the tube hot. If it be due to *Arsenic*, the sublimate produced will be a bright steel-looking ring, but if to *sulphurous acid*, there will be merely a deposit of yellowish-white sulphur formed.

(4) *Lead*, derived from the leaden chambers. Commercial sulphuric acid is said to contain from 0·1 to 0·15 per cent. (Dr. Ure.) Dr. Letheby states that he has not found usually more than from 0·03 to 0·08 per cent.

To detect its presence, mix the acid with about ten or twelve times its bulk of water, and note whether the mixture becomes milky or turbid. If so, it is due to the precipitation of sulphate of lead, which, although soluble in the strong acid, is insoluble in dilute.

(*a*) Collect the precipitate formed on a filter, diffuse in water, and pass sulphuretted hydrogen through the water, when, if it be lead, the white precipitate will be turned black. Or

(β) if the precipitate be mixed with twice its bulk of carbonate of soda, and heated on a piece of charcoal with the blowpipe, the lead will be reduced.

(γ) The best plan is to boil the precipitate for an hour in a saturated solution of carbonate of soda ; filter ; dissolve any undissolved residue in a little acetic acid. Divide into two parts, A and B.

Test (A) with *iodide of potassium*—which gives a yellow precipitate with lead.

Test (B) with *sulphuretted hydrogen*—which gives a black precipitate with lead.

(5) *Saline Impurities.*—Alkaline sulphates are often present in quantities varying from 0·4 to 0·6 per cent. (Dr. Ure.) These may be estimated by weighing the saline residue after the evaporation of a given quantity of the acid. Such impurities may be derived—*first*, from the nitre used in the manufacture of the acid ; and, *secondly*, they may be purposely added to increase its gravity, and so lead to the belief that the acid is more concentrated than it really is. One part of sulphate of potash added to one hundred of the acid increases its density as much as six parts in a thousand.

(6) *Carbonaceous Matter.*—This is easily recognised by the colour it imparts to the acid. It is generally due to the accidental admixture of the acid with pieces of straw, &c.

(7) *Selenious Acid* is said to be sometimes present ; and from the fact that selenium is not an uncommon constituent of iron pyrites, it is not improbable that it may be. Seleniuretted hydrogen is easily known—(1) by its intolerable odour ; and (2) that when burnt it has a smell of putrid horseradish.

Method of Purifying Sulphuric Acid.

Dilute the crude oil of vitriol with about five times its bulk of water ; pass sulphuretted hydrogen through the mixture for five or six hours ; allow the solid impurities to subside, and syphon off the weak supernatent acid. Mix this with a teaspoonful of common salt, and distil in a capacious retort containing a few fragments of glass, and connected with a receiver by a tube about four feet long and one inch in diameter. The portion which first passes over is to be rejected, as it consists chiefly of water with nitric, hydrochloric, and sulphurous acids, &c.

Varieties of Acids.

1. *Anhydrous Sulphuric Acid* (SO_3), which is obtained by decomposing sulphuric acid by anhydrous phosphoric acid, is a white solid. Its density is 1·9, and it boils a little above 50° C.

2. The sulphuric acids found in commerce contain variable proportions of this dry acid and water.

(*a*) *Nordhausen* is the strongest acid known. It contains about 90 per cent. of SO_3. Sp. gr. 1900.

(β) *Strongest English Acid.* It contains about 81 or 82 per cent. of SO_3. Sp.-gr. about 1845.

(γ) *Ordinary Sulphuric Acid* of English commerce. It contains about 78 per cent. of SO_3. Sp. gr. about 1843.

Properties.

Physical Properties.—The stronger acids have a syrupy appearance and those that contain above 85 per cent. of real acid, fume in the air. When pure, oil of vitriol has neither colour nor smell. The specific gravity depends upon its strength, good commercial samples having a gravity varying from 1836 to 1845. But so hygroscopic is the acid, that its exposure to the air for even a few minutes will materially alter its strength and specific gravity. The following table shows the strengths of acids of different gravities :—

Table showing the per-centage Quantities of Sulphuric Anhydride (SO_3) *and Sulphuric Acid* (H_2SO_4) *in Specimens of acids of different specific gravities.* (Attfield.)

Specific Gravity.	$SO_3 = 80$.	$H_4SO_4 = 98$.	Specific Gravity.	$SO_3 = 80$.	$H_3SO_4 = 98$.
1·8485	81·54	100	1·3884	40·77	50
1·8475	80·72	99	1·3788	39·95	49
1·8460	79·90	98	1·3697	39·14	48
1·8439	79·09	97	1·3612	38·32	47
1·8430	72·02	96·8 B. P.	1·3530	37·51	46
1·8410	78·28	96	1·3440	36·69	45
1·8376	77·46	95	1·3345	35·88	44
1·8336	76·65	94	1·3255	35·06	43
1·8290	75·83	93	1·3165	34·25	42
1·8233	75·02	92	1·3080	33·43	41
1·8179	74·20	91	1·2999	32·61	40
1·8115	73·39	90	1·2913	31·80	39
1·8043	72·57	89	1·2826	30·98	38
1·7962	71·75	88	1·2710	30·17	37
1·7870	70·94	87	1·2654	29·35	36
1·7774	70·12	86	1·2572	28·54	35
1·7673	69·31	85	1·2490	27·72	34
1·7570	68·49	84	1·2409	26·91	33
1·7465	67·68	83	1·2334	26·09	32
1·7360	66·86	82	1·2260	25·28	31
1·7245	66·05	81	1·2184	24·46	30
1·7120	65·23	80	1·2108	23·65	29
1·6993	64·42	79	1·2032	22·83	28
1·6870	63·60	78	1·1956	22·01	27
1·6750	62·78	77	1·1876	21·20	26
1·6630	61·97	76	1·1792	20·38	25
1·6520	61·15	75	1·1706	19·57	24
1·6415	60·34	74	1·1626	18·75	23
1·6321	59·52	73	1·1549	17·94	22
1·6204	58·71	72	1·1480	17·12	21
1·6090	57·89	71	1·1410	16·31	20
1·5975	57·08	70	1·1330	15·49	19
1·5868	56·26	69	1·1246	14·68	18
1·5760	55·45	68	1·1165	13·86	17
1·5648	54·63	67	1·1090	13·05	16
1·5503	53·82	66	1·0019	12·23	15
1·5390	53·00	65	1·0953	11·41	14
1·5280	52·18	64	1·0910	11·14 B. P.	13·65
1·5170	51·37	63	1·0887	10·60	13
1·5060	50·55	62	1·0809	9·78	12
1·4960	49·74	61	1·0743	8·97	11
1·4860	48·92	60	1·0682	8·15	10
1·4760	48·11	59	1·0614	7·34	9
1·4660	47·29	58	1·0544	6·52	8
1·4560	46·48	57	1·0477	5·71	7
1·4460	45·66	56	1·0405	4·89	6
1·4360	44·85	55	1·0336	4·08	5
1·4265	44·03	54	1·0268	3·26	4
1·4170	43·22	53	1·0206	2·446	3
1·4073	42·40	52	1·0140	1·63	2
1·3977	41·58	51	1·0074	0·8154	1

Questions bearing on the bulk and weight of some common popular measures of the acid may be asked in the witness-box. It may not be out of place here, therefore, to remark that a *teaspoonful* of distilled water commonly measures ʒi, and weighs 60 grains; a *tablespoonful* measures from ʒiv to ʒvj, and weighs from 240 to 360 grains; a *wine-glassful* measures from ℥iss to ℥ij, and weighs from 720 to 960 grains; a *teacupful* measures commonly about ℥v, and weighs about 2400 grains. Remembering that water is considered to have a specific gravity of 1000, it is easy from these data to make other calculations.

The boiling-point of the different acids vary. The ordinary English commercial acid requires a heat of 315·5° C. (600° F.). An acid having a specific gravity of 1780, boils at 223·9° C. (435° F.); and one having a specific gravity of 1650, boils at 176·6° C. (350° F.). The weaker the acid is, therefore, so the boiling-point is reduced. In distilling ordinary acid, the boiling-point is constantly rising, because the acid in the retort is constantly becoming more concentrated until at last it requires a temperature of 326·6° C. (620° F.) to boil it.

Chemical Properties.

(*a*) *Affinity for Water.*—This is very great. Dr. Letheby found (April, 1870) that 100 grains of acid (sp. gr. 1842) freely exposed to the air in a basin, absorbed 120 grains of water in four days, its bulk being thereby increased threefold, and its density lowered to 1340. The absorption of water, however, by larger quantities is not in like proportion: 1000 grains of the same acid freely exposed to the air in a similar manner only absorbed 232 grains of water in 24 hours, 430 grains in 48 hours, 580 grains in 72 hours, 690 grains in 96 hours, and 770 grains in 120 hours. The acid finally had a specific gravity of 1310, which is the point of dilution at which both weak and strong solutions of the acid arrive when exposed to the air. Moreover, the discolouration of organic bodies produced by the action of the acid is due to its affinity for water, and the consequent charring of the organic body

A great rise of temperature, and consequent condensation, occurs when sulphuric acid is mixed with water. This circumstance may be of considerable medico-legal importance, and we append, therefore, a table drawn up by Dr. Letheby, showing the heat and condensation resulting from various admixtures. The temperature of the day on which the experiments were made, was 22·22° C. (72° F.). It was noticed that the heat produced was a little greater when the water was poured into the acid than when the acid was poured into the water, and that the temperature of the mixture sinks very rapidly.

Table showing the Heat and Condensation resulting from various Mixtures of Sulphuric Acid and Water.

Sp. Gr. of the Acid used.	Weight of Acid used in Grains.	Bulk of Acid used.	Weight of Water used in Grains.	Bulk of Water used.	Temperature produced.		Bulk of Resulting Fluid when Cold.	Sp. Gr. of Resulting Fluid.
					F.	C.		
1840	3000	℥iij & ʒvj	1000	℥ij & ʒij	266°	130°·0	℥v	1616
1840	2000	℥iiss	do.	do.	252°	122°·2	℥iv	1548
1840	1000	℥j & ʒij	do.	do.	210°	98°·88	℥iij	1390
1840	500	ʒv	do.	do.	198°	92°·22	℥ij & ʒivss	1245
1840	250	ʒiiss	do.	do.	130°	54°·44	℥ij & ʒiij	1136
1616	1616	℥ij & ʒij	do.	do.	119°	48°·33	do.	1282
1548	1548	do.	do.	do.	108°	42°·22	do.	1246
1390	1390	do.	do.	do.	95°	35°·00	do.	1170
1245	1245	do.	do.	do.	81°	27°·22	do.	1074
1138	1138	do.	do.	do.	78°	25°·55	do.	1055

(β) *Action on Litmus.*—This is very marked. It begins to fail when the amount of dry acid present is reduced to 0·015 per cent.

(γ) *Action on Metals.*—Sulphurous anhydride is given off when *strong* acids (containing above 61 per cent. of SO_3) are boiled with zinc, copper, &c. The sulphurous anhydride can be detected by the blue tint developed on a piece of white paper moistened with iodic acid and starch. The action of *dilute* acids (*i.e.* acids with less than 61 per cent. of SO_3) on the common metals is to evolve hydrogen; an action which is observable when the solution does not contain more than 0·00128 per cent. of the dry acid.

(δ) *Action on Organic Substances.*

(1) *On Sugar.*—Its action upon all kinds of cane-sugar is immediate, producing discolouration by the abstraction of water or of its elements. The action on the sugar is not marked, however, at ordinary temperatures with an acid of less specific gravity than 1400; but if the temperature be raised, two drams of an acid containing not more than 0·005 per cent. of acid will be found capable of charring about five grains of sugar. Hence, we note that it is impossible to administer sulphuric acid on a lump of sugar by mistake for gin, oil of aniseed, &c., unless it be given immediately. Nor could it be given with sugar dissolved in water, as the charring effect produced by the acid in this way is even still more marked. It would be only possible to avoid this charring of the sugar, and then only to a limited extent, by thoroughly mixing the acid and the water before adding it to the sugar.

(2) *On Flour and Starch.*—An acid of sp. gr. 1800 added to flour, turns it of a violet-red colour, the change being due to the gluten that the starch contains. Weak solutions of sulphuric acid boiled with starchy matters, convert the starch into sugar, when iodine no longer has any action upon it. Very small quantities of an acid solution will effect this change. One grain of starch boiled with a solution containing 0·5 grain of free acid, undergoes perfect decomposition.

(3) *On Wood.*—Wood is charred immediately by an acid having a higher specific gravity than 1700. An olive-green tint is produced by an acid having a specific gravity from 1600 to 1700. With an acid below 1400 no change is produced on wood.

(4) *On Paper.*—Strong acids (sp. gr. above 1800) discolour white paper immediately. A weak acid, however, placed on white paper, and held to the fire, will after a time char the paper, owing to the evaporation of the water of the acid and its consequent concentration. The paper to which a very weak acid has been applied, becomes very brittle.

(5) *On Linen Cloth.*—Acids above sp. gr. 1700 carbonise linen cloth immediately. Solutions containing only 1-200th per cent. of free acid will rot the cloth, even if they do not discolour it.

Thus we see that the various substances named are charred by strong acids, whilst with weak acids they suffer conversion into grape-sugar.

(6) *On Salicine.*—Strong sulphuric acid produces a blood-red colour. No action is perceptible with acids below sp. gr. 1616.

(7) *On Gallic or Tannic Acid.*—Strong acids produce an orange-red colour.

(8) *On Strong Solutions of Albumen* (as undiluted white of egg).—An acid having a specific gravity above 1830 instantly coagulates it, changing it into a white opaque mass. In a few minutes the albumen will be found charred along the line where the acid touches it, whilst, after an hour or so, the albumen will dissolve, and a brownish-yellow liquid be formed. This solutive action does not take place with acids having a less specific gravity than 1400. Acids containing less than 40 per cent. of dry acid, have no action whatsoever on albuminous compounds.

(9) *On weak Solutions of Albumen* (as *e. g.* the white of one egg mixed with ℥j of water). Such solutions are coagulated immediately by acids having a specific gravity above 1390. From 1390 to 1010 the action of the acid is slow. An acid below specific gravity 1010 does not precipitate albumen at all.

(10) *On Blood Serum.*—An acid having a specific gravity of 1830 instantly coagulates, and then dissolves, albumen. An acid below 1008 specific gravity has no action whatsoever.

(11) *On Dead Mucous Membrane.*—Acids above specific gravity 1500 produce a whitening effect on dead mucous membranes, and an appearance of their having been coated with white paint. A mere opalescence is produced with the weaker acids. If painted with a strong acid, the membrane will be carbonised after a few minutes ; whilst with a weak acid, if the tissue be full of blood, a darkening effect only will be produced, due to the action of the acid on the blood-colouring matters. It is important to note the intimate combination that takes place when sulphuric acid acts upon animal tissues, in order to explain occasional unsuccessful attempts to obtain the poison in after-death examinations.

(12) *On Woollen Cloth.*—A dirty-brown colour is produced with acids having a specific gravity above 1830. The cloth soon becomes rotten and damp. This rottenness results when the cloth is treated even with very dilute solutions.

It is to be remembered that the combination of the acid and the albumen is a true chemical compound, from which the acid cannot be washed away by merely treating it with water.

Symptoms, Dose, &c.

These of course depend largely upon the concentration of the acid and upon the quantity swallowed. If concentrated, the pain produced is immediate, and intense. The mouth, throat, and tongue appear either as if covered with white paint, or else corroded and destroyed. It must be remembered that if the acid be given to children in a spoon, *the mouth may not be affected* from the spoon having been put far back, whilst, on the contrary, *the mouth only may be affected*, the patient having spit the acid out immediately and without having swallowed any. Death, however, may even under these circumstances take place from asphyxia. The voice is usually much affected, gaseous eructations occurring, with immediate and incessant vomiting of a brownish-coloured bloody liquid containing disorganised shreds of membrane. The pain becomes terrific, and the thirst great. The patient can neither swallow, nor speak, nor scarcely breathe ; the body is bathed in sweat, and the face is livid. Very little action of either bowels or kidneys usually takes place. The mouth is, after a time, found full of sloughs, and filled with thick bloody matters. Exhaustion succeeds, possibly accompanied with nervous symptoms, such as tetanus, epilepsy, &c. In a less concentrated state the symptoms may be more or less delayed, but recovery is not common. Always ask to see the first vomit, as in this the free acid is most likely to be found. Carefully search for spots about the patient's dress, as these may prove important evidence in the case. The state of the lips where some of the acid may have run out of the mouth should also be particularly noticed.

Death usually happens in from two to twenty-five hours, but it has occurred within an hour. It is always rapid when perforation occurs in the stomach, or when the action of the acid on the windpipe is severe and extensive. On the other hand it may be delayed for weeks and months, death resulting under these circumstances from secondary consequences, such as ulceration of the stomach or bowels, disease of the pylorus, chronic dyspepsia, or even starvation.

As regards *quantity* : half a dram has killed a child (æt. 1) in twenty-four hours, and a dram an adult in seven days. Recovery has occurred after one ounce of the strong acid in a boy aged nine. The action of the acid is much influenced by the quantity of food present in the stomach when the poison is taken, upon which, if abundant, the activity of the poison may be spent.

Treatment.

Your attention must be directed entirely to neutralising the poison. The administration of white of egg, soap and water, chalk and water, and better still, of calcined magnesia, must be the main treatment. Alkaline carbonates are not nearly so good as the corresponding lime and magnesia salts. The stomach pump must not be dreamt of. The plaster from the ceiling or from the wall may be used if nothing else be at hand. Burns on the skin with the acid may be treated first with carbonate of soda and then with a mixture of oil and lime-water. Nutritive enemata must be given if other means of administering food fail. Leeches to the pit of the stomach may be advisable.

Post-Mortem Appearances.

Examine carefully first of all for spots of the acid (probably of a dark brown colour), about the mouth and upon other parts where it may possibly have been spilt. The mouth, throat, and gullet will usually present the most marked effects, although cases are on record (one scarcely knows how to credit them), where these parts have not been affected at all!!! (*vide* "Lancet," March 3, 1838, p. 840). The mouth will appear soft and corroded, and as if covered with white paint, whilst the throat and gullet will be seen to have portions of the mucous membrane completely stripped off, or else dark-coloured blood (as if charred) effused in patches on an ash-grey surface. The stomach will usually be found intensely inflamed, either completely or in patches, and traversed with black lines. It is frequently contracted and collapsed, the mucous membrane appearing black, corrugated, and partly stripped off, and the surface underneath intensely red. In about one-third of the cases, and more frequently with sulphuric than with the other mineral acids, the stomach has been found perforated, the aperture being irregular and the edges black as if charred, intense inflammatory action being apparent on the parts surrounding the opening. The liquid in the stomach, which is usually of a tarry appearance (a mixture of black blood, acid, and mucus), when it escapes through the opening will be found to have attacked the surrounding parts and viscera. Of course the degree of acidity and consequently the extent of action will depend on the amount of acid swallowed, and the time that has elapsed before its escape from the stomach, but even when there is no perforation it is usual to find considerable inflammatory action with a coating of lymph on the peritoneal surface of the viscera. The bladder is generally empty and contracted. If life is prolonged for eighteen or twenty hours, more or less inflammation is certain to be found in the small intestines. In some cases the windpipe, the bronchial tubes, and also the lining membrane of the aorta have been found much inflamed. In one case, reported by Dr. Letheby, none of the acid went into the stomach, but passed down the trachea into the lungs. The lungs were charred and the rings of the trachea completely dissected out. The acid had escaped into the cavity of the pleura and dissolved the ribs on the left side.

It is stated that the bodies of persons poisoned with the mineral acids remain without smell for a long time after death, probably from the ammonia evolved being neutralized by the free acid.

An indigo-blue tint is often found in the mucous membranes after poisoning by this acid.

Tests.

1. *Taste.* The solution is perceptibly sour, even when it only contains 1-1000th part of anhydrous acid.

2. *Action on Litmus.* The reddening produced by the acid on litmus is distinct when 1 part of anhydrous acid is diluted with 6000 of water.

3. *Saturated Solution of Chloride of Calcium* gives a copious white precipitate, insoluble in dilute nitric and hydrochloric acids. A turbidity is distinctly apparent when the solution only contains 0·014 per cent. of acid.

4. *Acetate of Lead* gives a white precipitate, insoluble in dilute acids.

5. *Chloride of Barium* (or Nitrate of Baryta) gives a white precipitate, insoluble in free acids and caustic alkalies. The turbidity is apparent with a solution consisting of 1 of acid in 62,500 of water.

The baryta salt must never be added to a *neutral* or an *alkaline* solution, otherwise carbonic, phosphoric, oxalic acids, &c., may be precipitated, but all of which compounds are soluble in nitric or hydrochloric acids.

Inasmuch as other bodies give a similar precipitate with a baryta salt, it is necessary further to prove that the precipitate so produced is a sulphate.

(*a*) To do this the precipitate must be collected and dried, and mixed with about four times its bulk of powdered wood charcoal. The mixture is then to be heated strongly to redness in a platinum crucible. By this means the sulphate ($Ba\ SO_4$) will be reduced to sulphide ($Ba\ S$). Now add to the cold residue in a test tube or watch-glass a few drops of dilute hydrochloric acid (one to one), and apply heat, when sulphuretted hydrogen will be generated, which may be known either by its blackening moistened lead paper held near it, or if the gas be passed through a solution of acetate of lead, by the formation and precipitation of the black sulphide.

(*β*) The ignited residue of the sulphide may, if the quantity is very small, be placed on a piece of moistened lead paper and touched with a drop of dilute hydrochloric acid, when the lead paper will immediately be blackened.

6. *Nitrate of Strontia* gives a white precipitate, partially soluble in water and in dilute acids.

7. If sulphuric acid be gently heated in a test tube with some pieces of wood, copper, or mercury, &c., sulphurous acid is given off. This will impart a blue tint to a piece of starch paper moistened with iodic acid held over the tube. It must be removed the moment the tint is developed, as otherwise the colour will be bleached by prolonged exposure to the acid fumes.

8. *Veratria* added to a drop of the *concentrated* acid produces at first a yellow and afterwards a crimson red solution. No results are produced by its action on neutral sulphates.

9. Paper is carbonized by the *strong* acid, but not by the *dilute*. If you have to test a dilute acid, wet a piece of white paper at one spot with it and heat before a fire. As soon as the acid becomes sufficiently concentrated by evaporation, the paper will turn black.

The question is a very important one, *How are we to distinguish free acid from that in combination?* Various plans have been proposed:—

1. It has been suggested to evaporate the solution to dryness. If there is simply free sulphuric acid present, it is supposed that no sulphate will be found in the residue. This, however, may or may not be true.

2. It has been suggested to shake the solution up with finely powdered carbonate of baryta or lead, with which it is said the free acid will combine, but not the sulphates. But the fact is, combination occurs both with the free acid and with the soluble sulphates.

3. The following process the authors recommend. Divide the suspected liquid into two parts (1 and 2).

(1) Acidulate the one part with nitric acid, precipitate with a baryta salt, collect the precipitate, ignite and weigh.

(2) Evaporate the other part to dryness, dissolve the residue in water acidulated with nitric acid, filter, precipitate with a baryta salt, collect the precipitate, ignite and weigh.

The sulphate of barium of the former (1) denotes the amount of acid present *both free and combined*, whilst the latter (2) denotes the amount of acid present *in a combined state only*, whilst the amount of free acid may be estimated by the difference. But even this process is not entirely free from possible error,—1st, from the presence of a *super-sulphate*, which may by over-drying be calculated as free acid ; and 2ndly, if an alkaline chloride be present, the free acid, if there be any, may become fixed by combining with the alkaline base.

If you have a pure colourless solution containing sulphuric acid, and wish to test whether some of the acid be present in a free state or not, proceed as follows :—

(*a*) Evaporate the solution until it has acquired a gravity of 1140, then mix with it a few grains of sugar and boil. If the solution be rendered dark, it is a proof that free acid is present, the darkening effect on sugar not being produced by sulphates.

(*β*) Evaporate another portion of the solution until it acquires a sp. gr. of 1600. Heat this with a few grains of metallic copper. If a free acid be present, sulphurous acid fumes will be given off.

Toxicological Analysis.

We have now to consider the processes necessary to be employed when the acid is present along with organic matters and alkaline chlorides, such as is found in an ordinary toxicological investigation. You must not expect in such cases to find much, if any, free acid. The attempts at neutralizing the poison, its own power of combining with albuminous substances, the profuse vomiting induced, and the amount of fluid that is taken, owing to the intense thirst, render the chances doubtful of detecting any free acid at all. Nor can it be questioned that the detection of sulphuric acid in organic liquids is altogether a most difficult problem.

We have in dialysis no doubt a very ready method of separating sulphuric acid (as well as other acids), from its admixture with organic bodies. But it must be remembered that soluble sulphates also dialyse, although their presence may be easily determined by evaporating to dryness some of the water into which the dialysis has been effected.

(A) Dr. Letheby advises the following process:—

1st. Evaporate the contents of the stomach on a water bath down to a thick syrup Exhaust this with *strong alcohol* (sp. gr. 834) and filter, test the filtered liquid with baryta. Only *the free acid* will be taken up by the spirit.

2ndly. The residue (containing *soluble sulphates*) is then to be digested with *water*, filtered, and the filtrate precipitated with baryta.

3rdly. But if antidotes, such as lime, &c., have been given, the residue may still contain earthy sulphates, such as sulphate of lime, which is only very slightly soluble in water. Boil the remaining residue, therefore, for about an hour with an excess of *a solution of carbonate of soda*, when carbonate of lime will be precipitated and sulphate of soda left in solution. This is then to be filtered, acidulated with nitric acid, and precipitated with a baryta salt. In this way all the sulphuric acid present in the contents of the stomach may be estimated as—

(*a*) Free acid.
(*β*) Acid existing as alkaline sulphates.
(*γ*) Acid existing as earthy sulphates.

Each of these precipitates must be collected and weighed, and they should severally be proved to be sulphates by the process already indicated.

(B) But we have to note further that some of the sulphuric acid taken may have combined with albuminous bodies. In this state the mere washing the tissue will be altogether insufficient to remove it. The following process should then be adopted :—

Any tissue attacked by the acid, such as the coats of the stomach, is to be washed, wiped dry, and weighed. It is then to be dissolved by the action of heat in a solution consisting of one part of nitric acid, two of hydrochloric acid, and two of water. Allow this to stand for a time and filter, and precipitate the filtrate with nitrate of baryta; collect the precipitate and weigh. All the sulphate of baryta exceeding *half a grain per cent.* of the wet material used, may be regarded as abnormal acid brought into contact with the tissue in a free and corrosive state. Dr. Letheby, as well as the authors, from numerous experiments have never obtained more than 0·4 gr. of sulphate of baryta from normal wet tissue, and, as a rule, not more than 0·2 per cent. The results of dipping pieces of stomachs into dilute acids and testing them afterwards, prove that there ought to be no difficulty in deciding, with considerable accuracy, by this means, the amount of acid present over and above what is normal.

(C) Again; the urine should, if possible, be examined for the poison, not forgetting, however, that alkaline sulphates are present in natural and healthy urine. The amount of sulphuric acid in normal urine varies from 0·1 to 0·4 per cent. The urine, indeed, is the great eliminator of the sulphates. After a dose either of the free acid or of a sulphate has been taken, it will probably be found in the urine within two hours of its being swallowed, but it exists according to Bence Jones in this secretion in the greatest abundance after about seven hours. The amount of normal sulphuric acid in the urine is even increased by taking dry sulphur.

Amount of Sulphuric Acid present in Normal Urine as found by different Chemists.

	Per Cent. of Sulphuric Acid.
Simon, Neubauer, and Vogel .	from 0·10 to 0·23
Berzelius	0·23
Lehmann	from 0·36 to 0·37
Dumeril	0·13
Marchand	from 0·31 to 0·33
Letheby	from 0·024 to 0·31
Bence Jones	from 0·26 to 0·52
Tidy	from 0·16 to 0·38

Neubauer and Vogel state that about two grammes (31 grains nearly) s the average daily amount in the urine of health.

The greatest quantity is always found after taking food.

Hence, whilst we urge the advisability of examining the urine in cases where poisoning by sulphuric acid is suspected, it must not be forgotten hat the mere discovery of an excess of the acid scarcely constitutes mportant evidence of itself, unless other circumstances tend to confirm he suspicion. In the case of an adult who had swallowed a large dose f the acid, one of the authors found on the second day 28·74 grains, whilst Dr. Letheby has, after a similar time, found as much as 50·8 grains n the urine.

(D) *Detection of the Acid on Wood and Clothing.*—In almost every case of poisoning by this acid, spots here and there will be found. If it falls upon *wood* the ligneous tissue is blackened and discoloured. A little distilled water will easily remove the acid. If upon *linen*, when it is *trong* acid, it chars and corrodes it, and if it is *weak*, a damp soluble sugary compound will be left. If upon wool, the fabric is rendered damp, rotten, and discoloured. On *black cloth* the stain is first red, becoming after a time of a brown colour. In all cases where a strong acid has caused the stains, they continue damp for a very considerable time.

If the fabric be dyed with *indigo* the acid produces no action upon the colouring body; if with *archil and other blues*, the stain will be red; f with *logwood and madder*, it will be yellow; and if an iron mordaunt has been used a rust-red spot will be left. But never guess at stains. They constitute most important evidence, and great care is consequently needed before any conclusions are drawn from them. To detect the free acid proceed as follows. Cut out the spot that is stained, and

(1) Apply it to your tongue. If it is due to acid, it will very likely have a sharp taste.

(2) Moisten it with water and press upon it a piece of blue litmus paper, noting whether it be reddened or not.

(3) Digest it for some time in about half a dram of water, filter, and test the filtrate with nitric acid and chloride of barium.

In this way you will easily discover the acid, even after very considerable periods. Dr. Letheby found that he was able to recover by this means very nearly the whole of the acid he spilt on pieces of various fabrics. Christison recovered at least one-half after seven weeks. Dr. Taylor states that the acid may be found on fabrics after years have elapsed.

But it must be remembered that many articles of dress contain sulphuric acid, consequent upon having been treated during their manufacture with some sulphate, such as alum, copperas, &c. Always, therefore, make a quantitative examination of the amount of sulphate present in a similar weight of the sound fabric at the same time that you examine the portion which has been stained. In this way you will be able to compare the results of the two experiments.

Again: the fabric may have been washed, and by this means most of the acid got rid of. But the washing will not hide the alterations of colour and texture, nor will it remove the acid that exists in combination with the organic matter. In these cases also you must make quantitative analyses of both the sound and the injured parts, and then compare the results. For this purpose proceed as follows :—

Take given weights of the fabric, and heat with a little dilute nitro-muriatic acid (1 of $H\ NO_3$, 2 of $H\ Cl$, and 2 of $H_2\ O$), filter and precipitate with a soluble baryta salt. Then ignite the precipitate and weigh (*vide* the "Lancet," Oct. 2, 1841, p. 20).

Quantitative Estimation of Sulphuric Acid.

To estimate the total acid (free and combined), acidulate the liquid with nitric acid, and add an excess of a baryta salt. Collect the precipitate, ignite and weigh. Every 117 grains is equal to 40 grains of sulphuric acid, or in the proportion very nearly of three to one.

If the liquid contains only sulphates and sulphuric acid, the free acid can be estimated by a standard solution of carbonate of soda.

Cases of Poisoning by Sulphuric Acid.

1. "Lancet," Jan. 2, 1847, p. 43 (Dr. Letheby). Male : æt. 9. ʒj = 133 grains of anhydrous oil of vitriol.		
Symptoms.—Intense pain in throat and stomach ; lips as if smeared with white paint ; vomiting of charred mucus. Five minutes elapsed before antidotes were given. For five days the acid was found in the urine in large quantity.	*Result.*—Recovery.	
2. "Lancet," July 10, 1847, p. 35 (Dr. Chowne). Female : æt. 52. ʒss.		
Symptoms.—Immediate sense of strangulation ; voice remained natural ; œsophagus corroded. Death.	*Result.*—Death in 40 hours.	*Post-mortem.* — Epiglottis very inflamed ; œsophagus of a dirty ash red colour ; mucous membrane of the stomach destroyed, especially at the cardiac end.
3. "Lancet," Dec. 5, 1857, p. 579 (Dr. Winn). Female : æt. 4. A quantity ?		
Symptoms.—Very bad symptoms.	*Result.*—Recovery.	
4. "Medical Times and Gazette," July 20, 1850, p. 58 (Dr. Letheby). Male : æt. 6. A tablespoonful of strong acid.		
Symptoms.—Chin and lips excoriated ; tongue, mouth, and fauces white ; front of dress corroded by the acid ; retching, but no other very urgent symptoms. Acid present in the urine after 10 hours. 1000 grains gave = 7 grains strong $H_2\ SO_4$. In 10 days it was normal. Recovery rapid, constipation and diuresis being the only special symptoms that occurred. Never had afterwards any gastric symptoms.	*Result.*—Recovery.	
5. "Medical Times and Gazette," July 20, 1850, p. 58 (Dr. Letheby). Male : æt. 42 ; male : æt. 19 Quantity of acid thrown in the face.		
Symptoms.—Symptoms severe. In the elder the eye sloughed away.	*Result.*—Recovery.	

6.

"Medical Times and Gazette," July 20, 1850, p. 58 (Dr. Letheby). Female. 2 pennyworth (?).

Symptoms.—Found dead.	*Result.*—Death.	*Post-mortem.*—Poison did not reach the stomach, but eroded the epiglottis, and passed down the trachea into the lungs. The rings of the trachea were dissected out by the acid, and the lungs charred; the acid escaped into the cavity of the pleura, and dissolved the ribs on the left side.

7.

"Medical Times," Jan. 15, 1848, p. 258 (Dr. G. Corfe). Male: æt. 40. Half-a-pint.

Symptoms.—Seemed as if strangled; great agony, and could only speak in a faint whisper; epithelium of lips and tongue partially removed and white. Vomiting came on, succeeded by death.	*Result.*—Death in 17 hours.	*Post-mortem.*—Epithelium of œsophagus and stomach detached and corroded; throughout the intestines the mucous membrane was scarlet; stomach appeared as if black pitch had been laid over it.

8.

"Lancet," Nov. 26, 1853, p. 502 (Mr. Dickinson). Female: æt. 52. ℥ss with ʒss of water.

Symptoms.—Immediate pain; (carbonate of magnesia taken directly); constipation very troublesome. Recovery very rapid when it commenced. No corrosion of mouth or throat.	*Result.*—Recovery in 5 months.	

9.

"Lancet," 1870, p. 540. Female. Took some in her mouth and spat it out.

Symptoms.—Intense pain in mouth, throat, and stomach; difficulty of breathing for 2 days.	*Result.*—Recovery.	

10.

"Edinburgh Monthly Journal," June, 1850, p. 538 (Dr. Walker). Male: æt. 30. ℥ij nearly (s. g. 1·842).

Symptoms.—Vomiting in ¼ hour; but not immediate.	*Result.*—Death in 25 hours.	*Post-mortem.*—Pylorus much constricted; duodenum inflamed; aorta inflamed; no acid found in stomach.

11.

"Medical Gazette," vol. xxix., p. 147. æt. 1 year. Half a teaspoonful.

	Result.—Death in 24 hours.	

12.

Christison, p. 162. Male: adult. ʒj.

	Result.—Death in 7 days.	

13.

"Gazette Médicale," Dec. 28, 1850. Male: æt. 50. ʒiiiss.

	Result.—Death in 45 minutes.	

14.

"Lancet," 1837-8, vol. ii., p. 782 (Dr. Gardner). Male: adult. ℥ss.

Symptoms.—Salivation. Recovery after 12 days.	*Result.*—Recovery.	

15.

"Lancet," April 14, 1838, p. 93 (Dr. Wilson). Female: adult. A quantity (?)

Symptoms.—Lived in great suffering for 45 weeks. At the end of six months threw up whilst coughing the entire lining membrane of the œsophagus.	*Result.*—Death.	*Post-mortem.*—The lower two-thirds of œsophagus thickened and narrowed; stomach perforated; dark-coloured fluid in abdomen, but no inflammation.

16.

"Lancet," June 11, 1842, p. 365 (Dr. Scoffern). Female: adult. Dose (?)

Symptoms.—Black frothy matter issued from mouth; mind clear. In 12 hours rallied considerably. In 16 hours nervous symptoms set in, and death occurred in about 18½ hours after taking the poison.	*Result.*—Death in 18 hours.	*Post-mortem.*—All parts as far as the duodenum blackened and inflamed; kidneys very inflamed, and very acid to litmus.

17.

"Lancet," Feb. 6, 1869, p. 192 (Dr. Fripp). Male: æt. 40. About ℥ss on empty stomach.

Symptoms.—Vomiting and pain; mouth and fauces white and sodden; walked a mile immediately after taking it.	*Result.*—Recovery.	

18.

"Lancet," Dec. 7, 1872, p. 816 (Mr. Bond). Female: æt. 31, pregnant. Dose (?)

Symptoms.—Pain and vomiting; labour came on in the night. Patient progressed favourably for a fortnight, when she complained of sickness and difficulty of swallowing food; stricture of œsophagus came on, which had to be dilated with a catheter, and food introduced.	*Result.*—Death in 37 days.	*Post-mortem.*—Mouth and fauces found to have recovered their normal state; the stricture of œsophagus had almost disappeared, but there was complete absence of mucous membrane; stomach black; mucous membrane partially detached, and underneath it were found patches of fibrinous exudation ¼ of an inch thick.

19.

"Medical Times and Gazette," Feb. 16, 1867, p. 182 (Dr. Crawford). Female: æt. 35. A wineglassful.

Symptoms.—Immediate burning pain in throat and stomach. (Bicarbonate of soda was given after 10 minutes); violent vomiting.	*Result.*—Recovery.	

20.

"Medical Times and Gazette," July 26, 1873, p. 92 (Dr. Burder). Male: æt. 34. ℥ij.

Symptoms. — Speedy insensibility; vomiting of black acid fluid; lips white.	*Result.*—Death in 8½ hours.	*Post-mortem.*—Lips white and dry; tongue brownish-black and shrivelled; trachea inflamed, and covered with a brown glutinous liquid; stomach completely charred, and perforated at the cardiac end; two perforations in the duodenum. The jejunum looked as if covered with dirty white paint.

21.

"Medical Times and Gazette," April 21, 1860, p. 408 (Dr. Ogle). Male: æt. 53. A quantity.

Symptoms.—Dropped down after taking it as if in a fit, suddenly: lips corroded; collapse; (stomach pump used!)	*Result* —Death in 9 hours.	*Post-mortem.*—Mucous membrane of the tongue very slightly affected: œsophagus corroded; stomach and duodenum appeared as if charred; other parts inflamed.

22.

"Medical Times and Gazette," Nov. 10, 1855, p. 470 (Dr. Habershon). Female: æt. 55. A wineglassful of dilute acid taken during a fit of melancholy (1 to 3 or 4 parts water).

Symptoms.—Collapse in 2 hours; no stain on mouth or on lips; bloody vomiting and purging; sensible to the last.	*Result.*—Death on 11th day.	*Post-mortem.*—Mucous membrane injected at the posterior part of the mouth; epithelium of œsophagus nowhere destroyed; stomach dull slate colour, and mucous membrane here and there detached and destroyed. All the intestines much congested.

23.

"Medical Times and Gazette," Dec. 19, 1857, p. 629 (Dr. Jenner). Female. ℥ij of dilute acid (nearly half and half).

Symptoms.—Bloody vomiting; mouth white. In 2 hours collapse. On the sixth day retention of urine set in; sensible to the last.	*Result.*—Death on the 16th day.	*Post-mortem.*—Stomach perforated in three places; none of the contents escaped; stomach contracted; the pyloric half was most affected. Nothing to be remarked in the pharynx or œsophagus; upper part of duodenum inflamed; remainder of intestines normal.

24.

"Medical Times and Gazette," Feb. 21, 1863, p. 183 (Dr. Higinbothom). Male: æt. 50. ʒvj (s. g. 1·848) diluted with ℥ij of water taken on an empty stomach.

Symptoms.—Great pain; tongue of a dead white colour, but no vomiting or purging; collapse.	*Result.*—Death in 2½ hours.	*Post-mortem.*—Sides of tongue white and leathery; œsophagus brown and worm-eaten; not perforated; stomach internally covered with a black gelatinous coat, but no perforations.

25.

"British Medical Journal," Sep. 18, 1869, p. 325 (Dr. Wardell). Female: æt. 40. ℥iss of strong acid mixed with an equal quantity of water.

Symptoms.—Desperate agony; pupils contracted; mouth, lips, and throat pearly white; mind clear to the last.	*Result.*—Death in 3 hours.	*Post-mortem.* — Abdominal viscera charred; stomach perforated, the edges being thin and corroded; duodenum small and contracted; œsophagus greyish white and contracted; dress and skin much stained.

For Further Cases of Poisoning by Sulphuric Acid see:—

"Medical Times and Gazette," April 2, 1864, p. 380. (Death; 2 perforations in stomach.)
"Medical Times," April 10 and 24, 1847, p. 183 and 145. (Pontypool case.)
Schmidt's "Jahrb.," vol. clv., p. 7.
"Medical Gazette," vol. 48, p. 328. (Death in 34 hours.)
"Medical Gazette," vol. 45, p. 1102.
"Lancet," 1834, vol. i., p. 266; 1836, vol. i., p. 195.
"Medical Gazette," vol. i., p. 127; vol. vii., p. 27; vol. xxii., p. 76; vol. xxv., p. 944; vol. xxx., p. 352.
"Medical and Physical Journal," vol. i., p. 500.
"Medical Repository," vol. xiv., p. 160.
"Guy's Hospital Reports," vol. iv., p. 297.

NITRIC ACID. ($H NO_3$.)

(Hydric Nitrate—Azotic Acid—Fuming Spirits of Nitre—Glauber's Spirits of Nitre—Aqua Fortis—Solutive Water.)

Preparation.

Nitric acid is generally prepared by heating potassic or sodic nitrate with sulphuric acid, and distilling

$$H_2 SO_4 + Na NO_3 = NaH SO_4 + H NO_3.$$

Traces of nitric acid are formed when an electric spark is passed through moist air. For this reason rain water is usually found to contain a trace of nitric acid produced by atmospheric electricity. Potassic nitrate in India and sodic nitrate in Chili are found as efflorescences on the soil.

Nitrates are frequently found in the well waters of large cities, but not often in those of country places. This proves that their source may be traceable to living beings. Excrementitious matters liberate ammonia, and this undergoing oxidation furnishes the acid. We shall note directly that nitric acid can, under the influence of nascent hydrogen, furnish ammonia, whilst conversely ammonia can furnish nitric acid, or, more properly, a nitrate under certain circumstances, such as the presence of a strong base. Hence the amount of nitrates in a water is indicative of the pollution of a stream or well, by foul and putrefying products.

The cases of poisoning on record by nitric acid are much fewer than those by sulphuric acid.

Varieties of Nitric Acid.

1. *Anhydrous Nitric Acid* ($N^2 O^5$) was discovered by Deville in 1849. It is a solid crystalline body, and is prepared by passing chlorine over argentic nitrate, and condensing the products in an ice-cold receiver. It is not a permanent body.

$$4\ Ag\ NO_3 + 4\ Cl = 4\ Ag\ Cl + O_2 + 2\ N_2\ O_5.$$

2. *Commercial Nitric Acids* are of different degrees of strength. They are fuming liquids, colourless if pure, but generally tinted, owing to the presence of one or other of the lower oxides of nitrogen.

Their specific gravity varies with their strength. The ordinary acid has a gravity of about 1220. Rouelle is stated to have procured an acid with a gravity of 1583. The strongest acid has generally a sp. gr. of about 1512.

Impurities.

1. *Lower Compounds of Oxygen and Nitrogen.*—Their existence is generally due to the decomposition of the acid. Their presence is known by the colour they impart to the acid, the tint-depth being in direct proportion to the quantity present. If on diluting the acid with three times its bulk of water, and adding a little saturated solution of sulphuretted hydrogen, no turbidity is produced, you may be satisfied the acid contains at most but the merest trace of these impurities.

2. *Chlorine,* derived from the alkaline chlorides in the saltpetre, is known by a precipitate being produced with nitrate of silver.

3. *Iodine as Iodic Acid* may be derived from Chili nitrate of soda, which frequently contains alkaline iodides, being used in the manufacture of the acid. According to M. Lambert it is present in most samples of the commercial acid. To detect the impurity neutralize the acid with carbonate of soda, mix with a little starch, and add cautiously, drop by drop, strong sulphuric acid, when, if iodine or its compounds be present, the characteristic blue colour of the iodide of starch will be obtained.

4. *Sulphuric Acid* may be present, derived from the materials used in the manufacture of the acid. A white precipitate will be produced with a solution of nitrate of baryta.

5. *Iron* is a very common impurity. It will be precipitated as a yellowish brown deposit on super-saturating the acid with ammonia.

6. *Alumina; Potash and Soda Salts, &c.*, can be easily recognised in the saline residue left after the complete evaporation of the acid.

7. *Arsenic* has been mentioned as an occasional impurity. Neither Dr. Letheby nor the authors have ever found it in the acid.

Purification of Nitric Acid.

Dilute the acid with its own bulk of water. Heat the mixture, and whilst hot, add, for every 100 grains of the strong acid about one grain of bichromate of potash for the purpose of oxidizing any of the lower oxides of nitrogen that may be present. Then add nitrate of silver so

Table exhibiting the Specific Gravities and per-centage strengths of various solutions of Nitric Anhydride (N_2O_5) and Nitric Acid (HNO_3), (Attfield.)

Specific Gravity.	$HNO_3=63$.	$N_2O_5=108$.	Specific Gravity.	$HNO_3=63$.	$N_2O_5=108$
1·5000	92·983	79·7	1·2947	46·299	39·685
1·4980	92·053	78·903	1·2887	45·562	39·053
1·4960	91·124	78·106	1·2826	44·632	38·256
1·4940	90·194	77·309	1·2765	43·702	37·459
1·4910	89·264	76·512	1·2705	42·772	36·662
1·4880	88·334	75·715	1·2644	41·842	35·865
1·4850	87·404	74·918	1·2583	40·913	35·068
1·4820	86·484	74·121	1·2523	39·983	34·271
1·4790	85·545	73·324	1·2462	39·053	33·474
1·4760	84·615	72·527	1·2402	38·123	32·677
1·4730	83·680	71·730	1·2341	37·190	31·880
1·4700	82·755	70·933	1·2277	36·263	31·083
1·4670	81·825	70·136	1·2212	35·334	30·286
1·4640	80·895	69·339	1·2148	34·404	30·489
1·4600	79·966	68·542	1·2084	33·474	28·692
1·4570	79·036	67·745	1·2019	32·544	27·895
1·4530	78·106	66·948	1·1958	31·614	27·098
1·4500	77·181	66·155	1·1895	30·684	26·301
1·4460	76·246	65·354	1·1833	29·755	25·504
1·4424	75·316	64·557	1·1770	28·825	24·707
1·4385	74·386	63·760	1·1709	27·89	23·910
1·4346	73·457	62·963	1·1648	26·965	23·113
1·4306	72·527	62·166	1·1587	26·035	22·316
1·4269	71·587	61·369	1·1526	25·105	21·519
1·4228	70·667	60·572	1·1465	24·176	20·722
1·42 B. P.	70·00	60·00	1·1403	23·246	19·925
1·4189	69·737	59·775	1·1345	22·316	19·128
1·4147	68·807	58·978	1·1286	21·386	18·331
1·4107	67·878	58·181	1·1227	20·456	17·534
1·4065	66·948	57·384	1·1168	19·526	16·737
1·4023	66·018	56·587	1·1109	18·597	15·940
1·3978	65·09	55·79	1·1051	17·667	15·143
1·3945	64·158	54·993	1·1010	17·442	14·95
1·3882	63·229	54·196	1·0993	16·737	14·346
1·3833	62·299	53·399	1·0935	15·807	13·549
1·3783	61·369	52·602	1·0878	14·877	12·752
1·3732	60·439	51·805	1·0821	13·947	11·955
1·3681	59·579	51·068	1·0764	13·017	11·158
1·3630	58·579	50·211	1·0708	12·088	10·361
1·3579	57·650	49·414	1·0651	11·158	9·564
1·3529	56·720	48·617	1·0595	10·228	8·767
1·3477	55·790	47·820	1·0540	9·298	7·970
1·3427	54·860	47·023	1·0485	8·368	7·173
1·3376	53·930	46·226	1·0430	7·439	6·376
1·3323	53·000	45·429	1·0375	6·508	5·579
1·3270	52·069	44·632	1·0320	5·579	4·782
1·3216	51·141	43·835	1·0267	4·649	3·985
1·3163	50·211	43·038	1·0212	3·719	3·188
1·3110	49·281	42·241	1·0159	2·789	2·391
1·3056	48·355	41·447	1·0106	1·860	1·594
1·3001	47·180	40·440	1·0053	0·930	0·797

long as any curdy precipitate is formed. Set the acid aside for twenty-four hours, syphon off the clear liquid, and distil almost to dryness at a very gentle heat, rejecting the first half of the distillate. The acid will then be pure, and have a sp. gr. of about 1400.

If you require a very strong acid, it must be again distilled after mixing it with its own bulk of concentrated sulphuric acid. An acid of sp. gr. 1500, or even higher may be obtained by this means.

The *boiling point* of the acid varies somewhat—

An acid of	Sp. Gr.	1500	boils at	98·88° C.	(210° F.)
,,	,,	1450	,,	115·51° C.	(240° F.)
,,	,,	1420	,,	120·00° C.	(248° F.)
,,	,,	1400	,,	119·44° C.	(247° F.)
,,	,,	1350	,,	116·66° C.	(242° F.)
,,	,,	1300	,,	113·33° C.	(236° F.)
,,	,,	1200	,,	107·77° C.	(226° F.)
,,	,,	1150	,,	103·88° C.	(219° F.)

The congealing point of pure anhydrous acid is a little below that of water.

An acid of	Sp. Gr.	1500	freezes at	—40·00° C.	(—40° F.)
,,	,,	1400	,,	—40·55° C.	(—41° F.)
,,	,,	1330	,,	—41·11° C.	(—42° F.)
,,	,,	1215	,,	—41·66° C.	(—43° F.)

By keeping, and more particularly if it be exposed to light, nitric acid undergoes alteration, and becomes more or less coloured. It has a strong affinity for water (attracting it even from the air), evolving, at the time of its combination, a very considerable amount of heat. We have found that one volume of nitric acid (sp. gr. 1404) mixed with 1, 2, 3, 4, 5, and 6 volumes of water, yielded acids the densities of which were 1234, 1160, 1120, 1096, 1080, and 1070, whilst the mean specific gravities should have been 1202, 1135, 1101, 1080·8, 1067, and 1058.

The concentrated acid gives off colourless or orange-coloured fumes at ordinary temperatures. No residue is left on evaporation, if the acid be pure.

Nitric acid reddens litmus when the solution only contains 0·2 per cent. of the acid. It acts on nearly all metals except gold and platinum, the action varying according to the dilution and the temperature. An acid having a sp. gr. from 1·35 to 1·25 will usually be found to be the most powerful in its action on metallic bodies. Zinc dissolves in dilute nitric acid freely, some of the $H\,NO_3$ being reduced to $N_2\,O$. With a *very* dilute solution, the acid may even be completely reduced, and in the presence of metallic iron with a great excess of caustic potash, ammonia formed.

Nitric acid is an intense oxidizing agent; and this being the case, free hydrogen is never developed by its action on the metals. In other words, hydrogen is, no doubt, set free, but is instantly oxidized at the expense of the oxygen of the nitric acid. Thus—

1st. $Cu + 2\,H\,NO_3 = Cu\,2\,NO + {}_3H_2.$
2nd. $3H_2 + 2\,H\,NO_3 = 2\,NO + 4\,H_2\,O.$

The NO upon coming into contact with oxygen becomes oxidized, producing $N_2 O_4$, or $N_2 O_3$ which may be known by the deep red fumes evolved.

Action on Vegetable Matters.

1. On *saccharine bodies.* Provided the temperature does not exceed 21·1° C. (70° F.), the very strongest nitric acid produces no perceptible change on saccharine bodies, but if the mixture be raised to the boiling point, then the organic matter is more or less completely converted into oxalic acid. Schlesinger states that the best proportions of sugar and nitric acid in the fabrication of oxalic acid are four parts of well-dried sugar, and thirty-three parts of nitric acid (sp. gr. 1380). This will yield 56 to 60 per cent. of oxalic acid. With weaker acids (*e.g.* one having a sp. gr. of 1250), *saccharic acid* ($C_6 H_{10} O_8$) is formed, whilst with acids that are still weaker, after prolonged boiling, *sacchulmine,* a brown crystalline insoluble substance, is produced.

2. On *flour, starch, and bread.* A strong acid dissolves flour, and converts it into a jelly-like mass. A weak acid has very little action unless heat be employed, when oxalic, carbonic, and other acids are produced.

Bread mixed with an acid of sp. gr. 1300 is immediately stained yellow, whilst even with one of sp. gr. 1180, a similar change after a time takes place, the bread assuming a soft gummy consistence.

3. On *wood.* Nitric acid darkens wood wherever it touches it. The stain varies *with the strength of the acid,* and also very much *with the kind of wood* to which it is applied, in consequence of the varying quantities of resin contained in different species.

4. On *paper and linen cloth.* An acid below sp. gr. 1400 has no action either on linen or paper, unless they are boiled with the acid, when it dissolves them, oxalic and other acids being formed. A strong acid (sp. gr. 1500) converts paper or linen into a tough parchment-like body, which takes fire at a low temperature.

5. Many of the *vegetable alkalies,* such as morphia, brucia, nicotine, &c., assume a red tint with acids above 1300 sp. gr.

6. *Most vegetable colours* are discharged by strong nitric acid, whilst if the fabric be of animal origin, a brownish red stain will be left.

Action on Animal Substances.

1. *On strong and dilute albumen.* (See table on page 262.)

2. *Dead mucous membranes* are coagulated, and turned of a yellow colour by acids having a sp. gr. above 1180.

3. The *cuticle* is also stained by the action of the acid. An acid of 1300, colours the skin almost directly, whilst one of sp. gr. 1180 stains it in about five minutes.

4. On *woollen fabrics.* The acid produces a yellow stain on woollen bodies. With an acid of sp. gr. 1500, the tissue is decomposed, a yellow pulpy magma being left, which rapidly dissolves in an excess of the acid.

As regards the action, therefore, of nitric acid on albuminous substances, we note that whilst weak acids merely coagulate albumen (a nitrate of albumen being formed), strong acids effect a further change by producing a yellow substance, known as xantho-proteic acid.

The action of nitric acid, it must be further remarked, is rendered less energetic by dilution, but more energetic by its admixture with sulphuric acid, from the property the oil of vitriol possesses of abstracting water from bodies with which it has been brought into contact.

Table, showing the Action of Nitric Acids of Different Strength on Concentrated and Dilute Albumen.

Specific Gravity.	On strong Albumen (pure white of egg).	On dilute Albumen (such as either the white of 1 egg in 1oz. of water, or blood serum.)
1006	Coagulation in 24 hours.	No action.
1010	Coagulation in 1 hour; coagulum white and soft.	Action exceedingly slight after 24 hours.
1020	Coagulation in 10 minutes; coagulum becomes of a pale yellow colour in 24 hours.	Coagulation; coagulum white.
1100	Coagulation immediate; coagulum becomes of a full yellow tint in 10 minutes.	Coagulation immediate; coagulum yellow.
1500	Coagulation immediate; coagulum a deep yellow mass, dissolving in excess of acid with slight effervescence, but reprecipitated on dilution with water.	Coagulation immediate; the precipitated albumen yellow.

The *nitrates.*—All the neutral salts are soluble in water. No test agent except albumen furnishes an insoluble precipitate. The crystals of nitrate of potash are long, six-sided prisms, and those of nitrate of soda rhombic plates.

The nitrates deflagrate either when heated on platinum foil, with powdered charcoal; or when a crystal of the salt is thrown upon a hot cinder. A piece of filtering paper soaked in a solution of a nitrate, and dried, burns like touch-paper.

Symptoms of Poisoning, Dose, &c.

In addition to the general symptoms produced by the mineral acids, already described under sulphuric acid, we would note that the vomit in nitric acid poisoning will generally be found loaded with shreds of membrane having a citron yellow colour. The mucous membrane of the mouth at first may appear white (that is, if the acid swallowed be somewhat dilute), but it soon becomes of a bright yellow tint, which afterwards changes to a brownish yellow. A rash has been noticed in cases where the patient has survived a week. Sometimes stupor precedes death, but the mind generally is clear to the last. Death may result from secondary causes at a considerably later period.

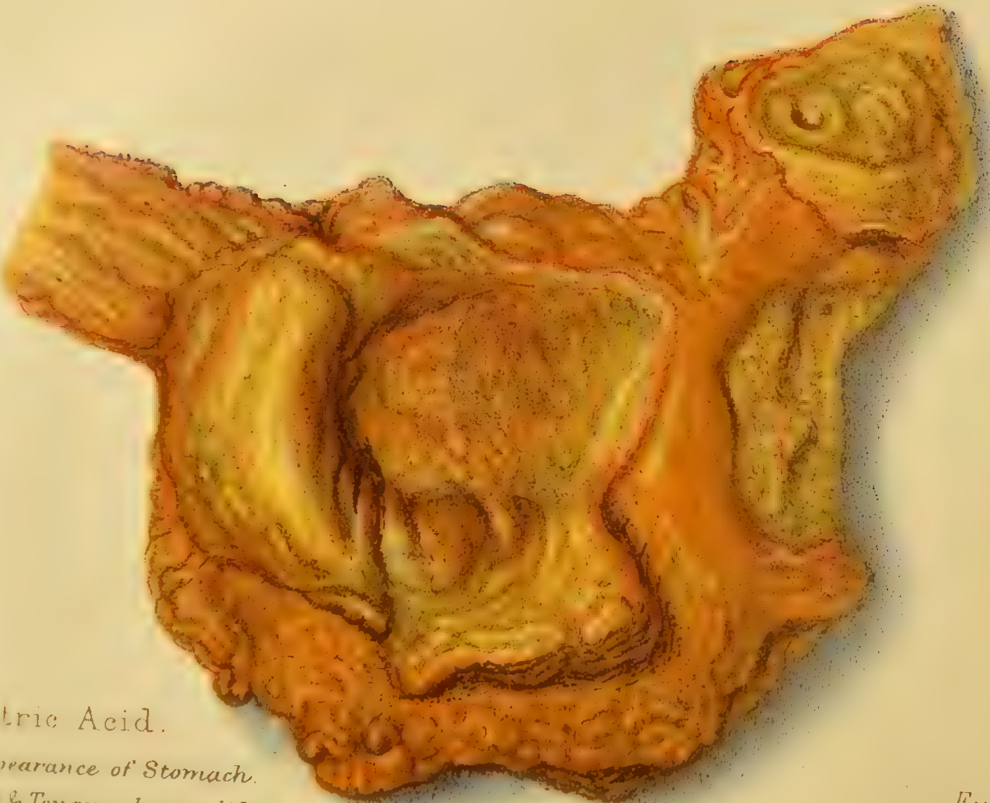
Two drams is said to have proved fatal to a boy aged thirteen, but recovery is in two cases recorded after half an ounce of the acid.

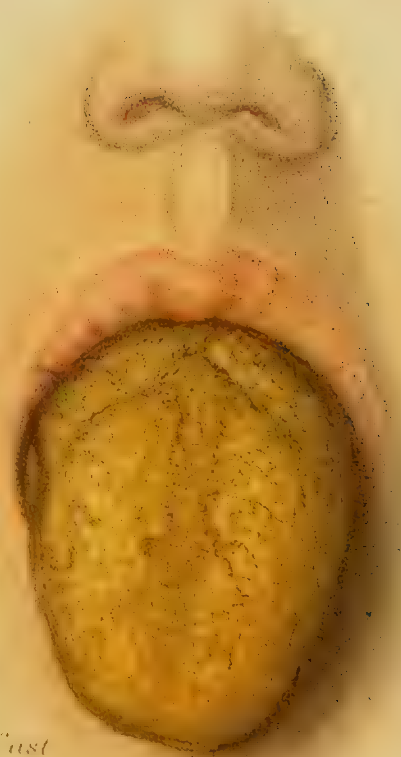
Death has been said to have occurred almost immediately, but it is as a rule delayed for several hours and days, or even longer.

Post-Mortem Appearances.

We have little to add to what has been already said respecting the post-mortem appearances after poisoning by sulphuric acid. The mouth,

Plate III.





Nitric Acid.

P.M Appearance of Stomach & Mouth & Tongue during life.

From a Wax Cast by Dr. Letheby.

E Burgess del et ch. lith

[illegible]

and any spots on the skin where the acid has been spilt, will appear of a yellow colour. Bromine and iodine also produce yellow stains, but the colour may in these cases be easily discharged by touching them with a solution of caustic potash, whilst the nitric acid stains, which are due to the production of xantho-proteic acid, are exceedingly permanent, and would be intensified rather than bleached by the action of the caustic alkali. The bladder is usually empty—the blood dark and thick. The stomach will probably be found in an exceedingly pulpy state and, perhaps perforated, the edges of the perforation having a yellow colour. Dr. Taylor remarks that in poisoning rabbits with the acid he has never found perforation. The action of the acid is seldom well-marked beyond the duodenum, by which time the corrosive properties of the poison will probably be destroyed.

Tests.

1. *Taste.*—Very acid. This is well marked when the solution contains only 0·3 per cent. of free acid.

2. Reddens *litmus* when the solution contains 0·2 per cent.

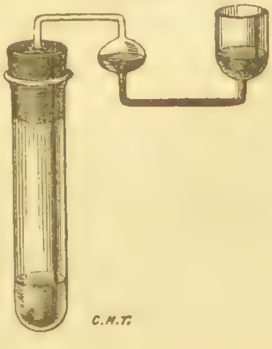
3. Nitric acid is completely *volatilized* by heat.

4. *Copper Test.*—Red fumes are given off when the acid is treated with a slip of copper foil, a deep blue coloured liquid being produced. These fumes may be known as follows :—

(*a*) They turn a solution of green sulphate of iron of a brown colour when passed through it. (An apparatus such as is represented in fig. 24 may be used.)
(β) They redden, but do not bleach, litmus.
(γ) They turn a mixture of starch and iodide of potassium blue, by setting free iodine.

Similar re-actions may be obtained with the nitrates, but it is necessary to set the nitric acid free by first adding a little sulphuric acid.

FIG. 24.



5. *Proto-sulphate of Iron.*—A strong solution of this salt is changed by nitric acid to a dark brown, which colour disappears on the application of heat. *In a dilute solution of free acid,* pour the iron solution so that it may float upon the acid, when an olive brown line will be apparent where the two solutions meet. *With a nitrate,* add first of all a little sulphuric acid, and *when the mixture is perfectly cold,* float the iron solution as already advised. The use of the iron-salt in solution is preferable to its use as a crystal in testing.

6. *Indigo Test* (Liebig).—A solution of nitric acid, or of a nitrate, is to be mixed with about half its bulk of sulphuric acid, coloured with a little indigo. In most cases the blue colour is immediately discharged, otherwise the bleaching effect will be manifest on the addition of heat.

This test should not be trusted to in the case of organic solutions.

7. *Gold Test.*—In testing *strong nitric acid* boil a little gold leaf in the acid, when no action on the gold will be observed ; add to this a little hydrochloric acid, in which a small piece of gold leaf has also been

boiled, to prove its freedom of action on the metal. The gold leaf will be found to dissolve freely in the mixed acids. *In testing a nitrate*, boil the gold leaf first in hydrochloric acid, in which it should remain undissolved, and then add the nitrate, when solution will result. That the solution of the gold has been effected will be known by the production of a purple tint on adding protochloride of tin to the solution. We do not recommend this test.

8. *Morphia* (O'Shaugnessy, 1829) produces with nitric acid a deep red, changing to orange.

9. *Brucia* (Berthemont, 1841). A nitric acid solution, or a solution of a nitrate mixed with about half its bulk of oil of vitriol, produces a carmine-tinted solution on the addition of a trace of brucia. This re-action is very delicate.

10. Nitric acid may be known—

(*a*) From hydrochloric acid, by giving no precipitate with a silver salt.

(*β*) From sulphuric acid, by giving no precipitate with a barium salt, and by its not charring paper.

Iodide of potassium (Mr. Higgin, "Pharm. Jour.," 1850, p. 84), and *narcotine* (Mialhe), &c., have been proposed as tests. They are not, we consider, of sufficient importance to demand a more detailed notice here.

Further, all the nitrates, except the albumen compound, are soluble in water, are crystalline, and deflagrate when heated on charcoal.

Having stated these several reactions with different tests, there are certain fallacies it is necessary to guard against.

1. Sulphuric acid often contains nitric acid.

2. The chlorates, bromates, and iodates act like nitrates, and especially with regard to the reactions of morphia and brucia. Fortunately these are uncommon bodies, and not likely to be sources of error to the toxicologist. In the case of a chlorate, it will be known by sulphuric acid turning it a blood red colour, which afterwards becomes yellowish-green, an odour of chlorine being evolved. With an iodate or bromate, sulphuric acid decomposes it, and liberates bromine or iodine.

Estimation of Nitric Acid.

1. With a pure solution of free nitric acid take the specific gravity of the liquid, and refer to the table (page 259) for the percentage of acid present.

2. Pour a given quantity of acid (sp. gr. 1020) on a weighed quantity of well dried powdered marble, and allow it to act for twenty-four hours. Evaporate the solution down to half its bulk. Filter, dry, and weigh the undissolved marble. Every 100 grains of the marble dissolved represents 108 grains of $N_2 O_5$.

3. Free nitric acid in solution may be estimated by saturating it with recently ignited carbonate of soda, every 53 grains of which will neutralize 54 grains of $N_2 O_5$.

4. But the solutions may contain other acids beside nitric acid. Other processes must then be adopted, which will be found in detail in chemical manuals.

Supposing no other acid be present but sulphuric acid, add an excess of baryta water, and evaporate to dryness. Treat the residue with water, and filter the solution. (The Ba. SO_4 is insoluble, and the remaining baryta over and above that which is combined with the nitric acid will, during evaporation, become changed into an insoluble carbonate.) Treat the solution with an excess of dilute sulphuric acid; collect the Ba SO_4, wash, dry, and weigh. Every 100 parts of Ba SO_4 = about 77·2 parts of H NO_3 sp. gr. 1424.

Toxicological Analysis.

(A) In conducting a toxicological investigation, test first of all the reaction of the organic liquid, remembering at the same time that antidotes may have removed all acidity, and even rendered it alkaline. If not already so, render the liquid alkaline with bicarbonate of potash, having diluted it sufficiently so that it may filter easily. Now boil, filter through fine muslin, and evaporate the strained portion to dryness on a water bath. Drench the residue with strong alcohol, in order to dissolve out the chlorides, sugar, &c., and test the undissolved portion for nitrates as already directed.

The urine should always, if possible, be examined. Normally it contains no nitrates, excepting, as Bence Jones pointed out, when ammonia or its salts have been taken. ("Medical Times," Aug., 1851, p. 220.)

(B) In examining the tissues it is to be noted that the compound of nitric acid with albumen is insoluble, and, that therefore, the acid will most likely be found in the stomach.

(*a*) If the tissues be *acid to litmus*, proceed as follows :—

Make a mixture of equal parts of water and sulphuric acid, and put twenty or thirty drops of the mixture into four test tubes.

To (1) add a little brucia ; no change should result. Add now a little piece of the tissue to be examined, when the solution, if nitric acid be present, will turn of blood-red colour.

To (2) add a trace of sulph-indigotic acid; no action should result. Add now a piece of the tissue, when the blue colour, if nitric acid be present, will disappear.

To (3) add a grain or two of copper filings and a piece of the tissue to be examined, and boil. The evolved vapours will, if nitric acid be present, give a blue colour to a piece of white paper moistened with a little starch and iodide of potassium solution.

To (4) add a solution of sulphate of iron. On adding a piece of the tissue, the solution will become of an olive-brown colour if nitric acid be present.

(*β*) If the tissues be *not acid to litmus*, boil them first with strong potash in order to break them up. Acidify with strong sulphuric acid, and test as above.

(C) Stains of nitric acid on articles of clothing appear yellow upon animal fabrics, and red upon articles dyed with vegetable colours. The stained cloth must be boiled in a little water, and the solution tested.

It has been stated that when the acid is placed on fabrics it is soon lost because of its volatility. This is a mistake. Dr. Letheby has found it on different fabrics after a lapse of five months.

Lastly. In every case when you are testing for nitric acid, endeavour to obtain the characteristic crystals of nitrate of potash.

Cases of Poisoning by Nitric Acid.

1. "Lancet," April 16, 1970, p. 549 (Mr. E. Adams). Male: æt. 21. ℥ss of strong acid.		
Symptoms.—No whitening or yellow tint about gums or mouth; great agony and vomiting of bloody fluid; constriction of œsophagus lasting for some time.	*Result.*—Recovery.	
2. "Guy's Hospital Reports," vol. xvii., p. 223 (Dr. Stevenson). ℥iij of acid.		
	Result.—Death in 17 hours.	*Post-mortem.* — Stomach perforated; ulceration of colon.
3. "British Medical Journal," Jan. 1, 1870, p. 7. Female: æt. 35. A quantity. (?)		
Symptoms.—Acute gastritis continued for several weeks, rapid emaciation and exfoliation of the mucous membrane taking place; was kept alive entirely by nutritive injections.	*Result.*—Recovery partial.	
4. "Lancet," May 8, 1847, p. 489 (Mr. Tomkins). Female: æt. 26. ℥ss of nitric acid. (She had previously been drinking.)		
Symptoms. – Vomiting; lips swollen and stained yellow; spasmodic closure of jaws. Recovery in a week.	*Result.*—Recovery.	
5. "Lancet," Nov. 24, 1860, p. 509 (Dr. Budd and Dr. Sansom). Male: æt. 36. 1 oz. of acid.		
Symptoms.—Immediate symptoms; got better from time to time.	*Result.*—Death in 6 months.	*Post-mortem.*—From mouth to stomach the tissues were puckered, constricted, and indurated; larynx uninjured. Death occurred from extreme irritability of the stomach.
6. "Medical Times," Aug. 15, 1846, p. 383 (Professor Puchett). Male. ℥ij on full stomach.		
Symptoms. — Immediate pain and vomiting; severe symptoms. On the twenty-second day the membranes of the stomach were entirely discharged, and in 66 hours after this he died.	*Result.*—Death on the twenty-fifth day.	*Post-mortem.*—Stomach perforated.

For other Cases of Poisoning by Nitric Acid:—

"British Medical Journal," April 30, 1870, p. 445. (Death. Acid taken for gin.)
Schmidt's "Jahrb.," vol. clv., p. 7.
"Glasgow Medical Journal," 1872, p. 221.
"Medical Gazette," vol. xii., p. 220.
"Medical Gazette," March, 1830.

HYDROCHLORIC ACID (H Cl).

(Spirits of Salt, Chlorhydric Acid, Muriatic Acid, Marine Acid.)

Cases of poisoning with the liquid acid are comparatively rare, but the evil effects produced by the escape of hydrochloric acid gas are a frequent subject of litigation. The hydrochloric acid of commerce is merely a solution of the gas in water.

Preparation.

The gas may be prepared in one or other of the following ways :—

(1) By mixing together common salt, sulphuric acid, and water, when hydrochloric acid gas is given off, sulphate of sodium remaining behind.

$$NaCl + H_2SO_4 = HNaSO_4 + HCl.$$

(2) By mixing hydrogen and chlorine together in equal volumes. The combination of the gases may be effected either by heat or by exposure to sunlight. No condensation results when the gases combine.

(3) By the action of chlorine on sulphuretted hydrogen.

$$H_2S + Cl_2 = 2HCl + S.$$

The gas must be collected by displacement or over mercury, because of its solubility in water.

Properties.

It is important to make ourselves fully acquainted with the general properties and physiological action of hydrochloric acid gas, inasmuch as law-suits (as we have already remarked) often result from the gas having been allowed to escape into the air in the course of the several manufacturing processes during which it is evolved.

Physical Properties. The gas is colourless, and about one-fourth heavier than the atmosphere (sp. gr. 1·257). Liberated, therefore, in the open air, it has a tendency to descend. It can be liquified by a pressure of 40 atmospheres at 10° C. (50° F.).

Chemical Properties.—The solubility of the gas in water is very great. At a temperature of 4·4° C. (40° Fahr.), water absorbs 480 times its volume. The application of heat to the aqueous solution expels the gas. When it escapes into moist air, white fumes are produced, which result from the combination of the acid gas with the moisture of the atmosphere, the water being condensed into liquid globules, which slowly evaporate. If ammonia gas be allowed to escape into an atmosphere containing only 0·01 per cent. of hydrochloric acid gas, white fumes will be immediately perceived. A drop of a solution of nitrate of silver is rendered perceptibly white when exposed to an atmosphere containing not more than one part of the gas in 200,000 parts of air. Litmus paper is distinctly reddened by an atmosphere of one part of the acid gas in 10,000 parts of air. The gas is neither combustible nor a supporter of combustion. The flame of a taper is visibly affected by an atmosphere containing only two per cent. of the gas, whilst it is extinguished when it constitutes a sixth part of the whole. Many of the common metals are slowly attacked by it.

Physiological Properties.—Its action is that of a powerful irritant, producing spasm of the glottis, and a feeling of intense and immediate suffocation. When the gas is even diluted with 1000 times its bulk of air, it produces extreme irritation of the lungs and violent fits of coughing. The conjunctival membrane is usually much affected, and intense pain in the eyes with a copious secretion of tears, produced. It occasions, moreover, extreme irritation of the skin. But the physiological action of the gas will be perfectly apparent even when the dilution is as great as one part in 10,000 of air.

If a mouse or a sparrow be put into the pure gas, it will be found to gasp and struggle vehemently for about two minutes, and then to fall down dead. We have found small animals die in about three or four hours when the gas is diluted with 1,500 times its volume of air, convulsions, with laborious and quickened respiration being the chief symptoms observed. But plants are infinitely more sensitive to the action of the gas than animals. We have found that if a geranium be introduced into an atmosphere containing only one part of the gas in 25,000 parts of air, it will begin to droop and wither within one hour.

Nuisances Arising from the Escape of the Gas.

The various trade operations in which muriatic acid gas is set free deserve mention.

(1) *The extraction of the copper* (2 *to* 4 *per cent.*) *from the pyrites*, after it has been used by the sulphuric acid maker, is effected by mixing the crushed pyrites with common salt (3 cwt. to a ton of pyrites), and then roasting the mixture in a reverbatory furnace. A small quantity of sulphurous acid, and enormous quantities of hydrochloric acid gas are thus generated, which have too often been allowed to escape freely into the shaft.

(2) *In the manufacture of common bottle glass*, as well as in the process of glazing the commoner kinds of pottery, silica and common salt are fused together, immense volumes of hydrochloric acid gas being thereby generated. The alkali of the common salt combines with the fixed acid, forming a fusible glass or glaze, whilst the volatile acid escapes.

(3) *In brick and cement burning* considerable quantities of the acid gas are generated. In brick burning it is derived from the cinders (breeze) which are charged with salt from house dust-bins, whilst in cement burning it is derived from the mud of tidal rivers, from which mud cement is made by admixture with chalk.

(4) Lastly and specially, "*alkali works*" have until lately proved serious nuisances on account of the large quantities of hydrochloric acid gas set free from them. The Act of 1863 compelled the alkali manufacturers to condense 95 per cent. of the gas that might be produced from the whole of the materials used, whilst a later Act further limits the amount to one-fifth of a grain of the gas per cubic foot of the air leaving the works. Other manufactures by the Act of 1874 are now included under the Alkali Act of 1863.

In alkali works, and in other manufactories, such as those of the potter and cement maker, the use of proper coke towers or scrubbers, is generally adopted for the purpose of condensing the fumes. In the case of the brick-maker, the cinders or breeze used should be coke breeze, or if "household breeze" be employed, it should previously be well washed, either by exposure to rain, or in some other way, to get rid of the common salt with which it may be mixed.

Liquid Hydrochloric Acid.—Properties.

When pure it is colourless, the colour of the ordinary commercial acid being due to impurities. A table showing the percentage strength of the acid compared with its density (taken from Dr. Attfield's Chemistry) we give in detail.

Table of the quantity of Hydrochloric Acid in the Liquid Acid of different Specific Gravities. (*Ure.*)

Specific Gravity.	Acid of 1·2 in 100.	Hydrochloric Acid Gas.	Specific Gravity.	Acid of 1·2 in 100.	Hydrochloric Acid Gas.
1·2000	100	40·777	1·0980	49	19·980
1·1982	99	40·369	1·0960	48	19·572
1·1964	98	39·961	1·0939	47	19·165
1·1946	97	39·554	1·0919	46	18·757
1·1928	96	39·146	1·0899	45	18·349
1·1910	95	38·738	1·0879	44	17·941
1·1893	94	38·330	1·0859	43	17·534
1·1875	93	37·923	1·0838	42	17·126
1·1857	92	37·516	1·0818	41	16·718
1·1846	91	37·108	1·0798	40	16·310
1·1822	90	36·700	1·0778	39	15·902
1·1802	89	36·292	1·0758	38	15·494
1·1782	88	35·884	1·0738	37	15·087
1·1762	87	35·476	1·0718	36	14·679
1·1741	86	35·068	1·0697	35	14·271
1·1721	85	34·660	1·0677	34	13·863
1·1701	84	34·252	1·0657	33	13·094
1·1681	83	33·845	1·0637	32	12·597
1·1661	82	33·437	1·0617	31	12·300
1·1641	81	33·029	1·0597	30	11·903
1·1620	80	32·621	1·0577	29	11·506
1·1599	79	32·213	1·0557	28	11·109
1·1578 B. P	78	31·805	1·0537	27	10·712
1·1557	77	31·398	1·0517	26	10·316
1·1536	76	30·990	1·052	B. P.	10·290
1·1515	75	30·582	1·0497	25	0·919
1·1494	74	30·174	1·0477	24	9·922
1·1473	73	29·767	1·0457	23	9·126
1·1452	72	29·359	1·0437	22	8·729
1·1431	71	28.951	1·0417	21	8·332
1·1410	70	28·544	1·0397	20	7·935
1·1389	69	28·136	1·0377	19	7·538
1·1369	68	27·728	1·0357	18	7·141
1·1349	67	27·321	1·0337	17	6·745
1·1328	66	26·913	1·0318	16	6·348
1·1308	65	26·508	1·0388	15	5·951
1·1287	64	26·098	1·0279	14	5·554
1·1267	63	25·690	1·0259	13	5·158
1·1247	62	25·282	2·0239	12	4·762
1·1226	61	24·874	1·0220	11	4·365
1·1206	60	24·466	1·0200	10	3·998
1·1185	59	24·058	1·0180	9	3·571
1·1164	58	23·650	1·0160	8	3·174
1·1143	57	23·242	1·0140	7	2·778
1·1123	56	22·834	1·0120	6	2·381
1·1102	55	22·426	1·0110	5	1·984
1·1082	54	22·019	1·0080	4	1·588
1·1061	53	21·611	1.0060	3	1·191
1·1041	52	21·203	1·0040	2	0·795
1·1020	51	20·796	1·0020	1	0·397
1·1000	50	20·388			

Hydrochloric acid boils at different temperatures, the boiling point being dependent on its strength. Dr. Dalton's table, however, shows that both weaker and stronger acids boil at a lower temperature than that having a gravity of 1094. The liquid acid freezes at about —51·11° C. (— 60° Fahr.).

Dalton's Table of the Boiling Points of Liquid Hydrochloric Acid.

Specific Gravity.	Boiling Points.		Specific Gravity.	Boiling Points.		Specific Gravity.	Boiling Points.	
	Fahr.	Cent.		Fahr.	Cent.		Fahr.	Cent.
1166	170	76·66	1121	228	108·88	1035	219	103·88
1154	190	87·77	1094	232	111·11	1018	216	102.22
1144	212	100·00	1075	228	108·88	1009	214	101·11
1136	217	102·77	1064	225	107·22			
1127	222	105·55	1047	222	105·55			

Chemical Properties of the Liquid Acid.

1. *Its affinity for water.*—The elevation of temperature resulting from the admixture of the acid with water is not great, but its affinity for water is well marked by the solution fuming in the air, even when it does not contain more than 20 per cent. of free acid.

2. *The action of ammonia* on the liquid acid is manifest when the solution only contains 8 per cent. of free acid.

3. *The reddening of litmus* is marked when the solution only contains 0·012 per cent. of free acid.

4. *The action of the acid on earthy carbonates* takes place when the solution contains 2 per cent. of free acid (sp. gr. 1010), but by the application of heat slight effervescence will be manifest when the liquid only contains 0·05 per cent. of free acid.

5. *The action on metals* is in some cases energetic. With *zinc* this will be apparent with a solution containing not more than from 0·5 to 0·8 per cent. of acid. With *iron* a 1·5 per cent., and with *tin* a 4·0 per cent. acid solution is needed, whilst with other metals, such as copper, bismuth, lead, antimony, arsenic, and mercury, the action is less energetic, and considerably slower. The metals attract the chlorine, and set free the hydrogen of the acid.

6. *Action on metallic oxides.*—Upon low oxides a chloride merely is formed, whilst on high oxides, such as plumbic dioxide ($Pb. O_2$), manganesium peroxide ($Mn O_2$) or chromic trioxide ($Cr O_3$), chlorine is set free as well.

7. *Its action on high oxygen acids*, such as nitric, chloric, bromic, and iodic acids, &c., is peculiar, chlorine being set free.

8. *Hydrochloric acid takes away the colour from ordinary writing ink*, on account of its affinity for the iron of the compound. A solution containing only 0·4 per cent. of acid discharges the colour. The iron is in this way removed, whilst the reddish brown stain of galls is merely left, and may be got rid of with a little chlorine water. A weaker acid than this, however, will act if time be allowed.

9. *The action on organic bodies :*—

(α) *On cane sugar.*—Cane sugar is instantly converted in the cold into grape sugar by an acid having a sp. gr. 1200. If heat be applied, ulmic and sacchulmic acids are formed.

(β) *Other vegetable substances*, such as wood, &c., are discoloured.

(γ) *On albumen solutions.*—These are coagulated by acids with a sp. gr. over 1015. The action begins in about a quarter of an hour, and is complete in one hour. An acid solution containing less than 3 per cent. has no action.

(δ) *On dead mucous membrane*, as, *e.g.*, the interior of the stomach.—The strong acid instantly whitens it, and produces in a few minutes a gangrenous greenish spot. A solution containing 0·5 per cent. of free acid takes about a quarter of an hour to act. The acid has a most remarkable solutive power on animal substances, an action considerably aided by heat. Liebig states that the fibrine of flesh differs from the fibrine of blood, not merely in that the former contains less nitrogen, but that it is soluble in dilute hydrochloric acid, blood fibrine being insoluble, and merely swelling up when subjected to the action of the acid. (" Chemical Gazette," 1850, p. 170.)

Lastly, we may note hydrochloric acid has some antiseptic properties, although they are not remarkable for their intensity.

The chlorides are generally white, and soluble in water, excepting those of silver, lead, and the subsalt of mercury ($Hg_2 Cl_2$).

Hydrochloric acid gas is produced when a soluble chloride is heated with dilute sulphuric acid.

Impurities.

1. *Sulphurous acid*, derived from the deoxidation of the sulphuric acid either by the organic matter of the salt, or by the metal of the still. The commercial acid may contain as much as 11 per cent. of sulphurous acid (Savory). The presence of sulphurous acid may be known as follows :—

(*a*) Treat some of the acid in a test glass with a rather large quantity of protochloride of tin (or metallic tin may be used) ; cover the glass over with a piece of filter paper moistened at one spot with acetate of lead. If sulphuretted hydrogen be generated (which will be known by its blackening the lead paper), it indicates the presence of sulphurous acid (Wockenroder). This test is very delicate.

(*b*) Dilute the acid with water ; add to the solution pure granulated zinc, and pass the gas generated through a solution of acetate of lead, which will be blackened if sulphurous acid be present. The nascent hydrogen reduces the sulphurous acid, and combines with the sulphur to form $H_2 S$. (Fordos and Gelis.)

(*c*) To estimate the quantity of sulphurous acid present, precipitate the sulphuric acid with an excess of chloride of barium ; filter, and boil the clear filtrate with its own bulk of nitric acid. Any fresh sulphate of baryta now precipitated corresponds to sulphurous acid. A little fresh baryta solution should afterwards be added, so as to make certain that the whole is precipitated.

2. *Sulphuric acid* may be known by a soluble salt of baryta producing a white precipitate.

3. *Free chlorine*, which imparts a greenish yellow tint to the acid solution, may be known—

1. By the odour.
2. By the solution dissolving a little piece of gold leaf.

3. By its bleaching a solution of indigo.
4. By its precipitating the sulphur from a solution of sulphuretted hydrogen.

4. *Iodine and bromine* are sometimes present, and are derived from impurities in the common salt.

5. *Chloride of arsenic,* derived from the sulphuric acid, may be known either by the evolution of arseniuretted hydrogen, or by Reinsch's test. (*See* Arsenic.)

6. *Chloride of tin* (mentioned by Gmelin) will be precipitated as a yellow precipitate, by passing sulphuretted hydrogen through the acid, the precipitate gradually becoming of a brown colour.

7. *Chloride of lead* (Vogel), may be present, and will be derived from the lead in the sulphuric acid, as well as possibly from other causes.

8. *Chloride of iron* (Rose and Graham) may be recognized by neutralizing the acid with carbonate of soda, and adding tincture of galls or potassic ferrocyanide. With the former a violet, and with the latter a blue precipitate will be obtained.

9. *Other chlorides and metallic substances* may be recognized by evaporating the acid to dryness, and examining the residue.

10. *Organic matter.*—This is often the cause of the dark colour of the acid. It may be known by evaporating the acid to dryness, and noting whether the residue becomes charred by a continued application of heat.

Preparation of Pure Hydrochloric Acid.

It will at all times be found easier to *make* a pure acid than to *purify* a bad one. The following two methods of preparing pure hydrochloric acid are recommended:—

(*a*) Dilute one pint of good sulphuric acid with six pints of water in a glass vessel, and pass a stream of well-washed sulphuretted hydrogen through the mixture for some hours. After doing so allow it to stand undisturbed for five or six days. When the precipitate formed has thoroughly settled, syphon off the supernatant acid, and after adding a teaspoonful of common salt, put the acid into a retort and concentrate by heat to the original bulk.

Fill a large retort half full of good salt, and add to it the sulphuric acid thus prepared. The retort must have fitted to it a piece of bent glass tube, of such a length and shape that the end may pass into a Winchester pint bottle half full of pure distilled water, the end of the tube dipping about $\frac{1}{8}$th of an inch under the water. The bottle must be fitted with a cork, and a second tube, connected with a second bottle of water, so arranged as to convey any unabsorbed acid vapour that escapes from the water of the first bottle into the water of the second. The acid thus obtained will generally be found pure, but should always be carefully tested before using, both by passing sulphuretted hydrogen through it, as well as by boiling with copper, the purity of which has been already proved by analysis.

Another method is the following:—

(β) Take an acid having a density between 1115 and 1164.

Add to it a little pure protochloride of tin in hydrochloric acid, and let the acid stand for several days in a well-stoppered bottle. The arsenic is thrown down in a metallic form, mixed with a little tin. Syphon off the clear liquid and distil, rejecting the first tenth as being liable to contain a little arsenic. The rest is absolutely free from it.

Symptoms, Dose, &c.

We have very little to add to what has been already said respecting the symptoms of poisoning by sulphuric acid, excepting in one particular. Just as ammonia is a *volatile alkali*, and so produces more active laryngeal symptoms than potash or soda, so hydrochloric acid, being a *volatile acid*, will be found more liable to set up intense laryngeal symptoms than the other mineral acids.

In poisoning by hydrochloric acid the tongue and throat at first appear white, but gradually become discoloured and rotten.

Death has occurred in as short a time as two hours.

Recovery is not common.

One dram has proved fatal to a girl aged 15.

(For treatment and post-mortem appearances, *see* Sulphuric Acid.)

We may observe here that some attention has been directed to the presence of notable quantities of arsenic in the acid of commerce, from the fact that certain injurious results are said to have occurred from the use of the common acid mixed with carbonate of soda in lieu of yeast, for making a light, and, as it is termed, digestible unfermented bread. The amount of the acid used for this purpose is, of course, very small, and the amount of arsenic consequently present in the acid, to do harm, must be very large. Still, we are aware that very small doses of arsenic, constantly repeated, have in some cases produced startling results. (*Vide* "Monthly Journal," 1850, p. 288.)

Tests.

1. *Odour.*—Not perceptible in solutions containing less than 8 per cent.

2. *Taste.*—Very acid, perceptible when the solution contains 0·05 per cent.

3. *Action on litmus.*—Perceptible in a solution containing 0·002 per cent.

4. The pure concentrated acid leaves no residue when evaporated to dryness.

5. *Acetate of lead* gives a white precipitate ($Pb\ Cl$) when the solution contains above 2 per cent. The precipitate is almost insoluble in dilute nitric acid, but is somewhat soluble in boiling water, from which crystals may be obtained.

(A white precipitate is also produced by acetate of lead with several other acids.)

6. *Mercurous nitrate* gives a white precipitate of calomel ($Hg_2\ Cl_2$), insoluble in nitric acid. This re-action may be observed if the solution only contains 0·006 per cent. of acid.

7. *Nitrate of silver* gives a white curdy precipitate, either with the free acid or with its soluble compounds. The precipitate acquires a purple colour on exposure to light. It is insoluble in boiling nitric acid, but is very soluble either in ammonia solution, or in cyanide of potassium, or

in hyposulphite of soda. Collected and fused the mass becomes horny. The 1-1000th of a grain of $H\,Cl$ can be thus detected.

(Note, hydrocyanic acid also forms a white curdy precipitate with nitrate of silver, the precipitate being insoluble in cold nitric acid, but soluble to an extent in ammonia, and in nitric acid when boiled. But when the cyanide of silver is heated in a tube, cyanogen gas, which is inflammable, is given off, which property at once serves to distinguish it from the chloride.)

8. Heat a liquid containing free hydrochloric acid with peroxide of manganese ($Mn\,O_2$), when chlorine will be evolved, which may be known (*a*) by its greenish yellow colour; (*b*) by its bleaching litmus; and (*c*) by its giving a blue colour to a piece of paper moistened with starch and potassic iodide.

Quantitative Estimation.

(1) If it be pure acid, take the gravity, and refer to the table (page 269) for the strength.

(2) *If the acid be present as free acid only*—

(*a*) The solution may be carefully neutralised with pure ignited carbonate of soda.

Every 53 grains of the carbonate used corresponds to 37 grains of dry hydrochloric acid—

(*β*) Or act with a given quantity of the acid solution on a given weight of dry powdered marble. When the action has ceased, carefully collect the undissolved marble, dry, and weigh.

Every 50 grains of the marble dissolved corresponds to 37 of dry hydrochloric acid.

(3) *If the acid be present both in a free and a combined state*, precipitate the acid with nitrate of silver in a solution rendered acid with nitric acid. Collect the precipitate, dry, and carefully fuse.

100 grains of chloride of silver = 24·74 of anhydrous hydrochloric acid
= 77·80 parts of acid, sp. gr. 1·15.

(4) *To estimate separately the free and the combined acid*, carefully, and at as low a temperature as possible, distil over about two-thirds of the solution under examination. Estimate the chlorine in both distillate and residuum. The former corresponds to the free, and the latter to the combined acid.

Toxicological Analysis.

In conducting a toxicological inquiry, note (1) if the organic liquid be acid; (2) if it contains sulphuric acid or a sulphate; (3) if it evolves a vapour that whitens nitrate of silver (hydrocyanic acid).

Distil the liquid portion in a retort *nearly to dryness*, inasmuch as animal substances retain hydrochloric acid with great tenacity. The distillate must then be acidulated with nitric acid, and precipitated with nitrate of silver for free acid.

Several sources of fallacy must be guarded against in the distillation.

1. *The evolution of a volatile chloride* (such as chloride of ammonium), which is not unlikely to be present in animal fluids.

The use of a chloride of calcium bath for the distillation, as suggested by Christison, would prevent the temperature rising above 115·55° C. (240° F.) This source of error would thus be obviated, inasmuch as chloride of ammonium is not volatile at this heat.

2. *It is stated that the gastric fluid naturally contains free hydrochloric acid.*—On the one hand Prout, Children, Berzelius, Gmelin, Tiedemann, Dunglisin, and Liebig assert its presence. On the other hand, Hunefeld, Blondlet, Barreswill, Bernard, and Lehmann, assert the contrary, explaining that the reactions obtained by the other chemists in distilling the gastric fluid, are due to the decomposition of a soluble chloride by a more fixed organic acid, such as lactic acid. Admitting, however (and for toxicological purposes it is safer to admit it), that this may prove a possible fallacy, it is worth remembering that the largest amount of hydrochloric acid obtained by the various chemists does not exceed the 1-5000th part of the weight of the materials operated upon.

The urine should always be examined in cases of suspected poisoning by hydrochloric acid. Orfila's experiments are of great interest. *In nine healthy dogs*, the urine of which he examined, the following were the results :—In two cases the precipitate of chloride of silver obtained was equal to 0·332 per cent. of the urine ; in three cases it was equal to 0·462 per cent. ; and in four cases it was equal to 0·276 per cent.

Further, to two dogs he gave 185·25 grains of the acid, when the chloride of silver obtained from the urine was equal to 2·66 per cent., whilst in three other cases where 123·5 grains of acid had been administered, the chloride of silver obtained was equal to 1·96 per cent.

Orfila's experiments prove—

(1) That the urine contains normally a variable proportion of alkaline chlorides.

(2) That the quantity present in excess of what is normal, is proved to be in direct proportion to the amount of the acid swallowed.

(3) That in disease the quantity of chlorides present is usually small, because generally but little food is taken.

(4) That the largest amount of soluble chlorides found in healthy urine is 12 per cent. of the solid extract, whilst 10 per cent. may be regarded as the average.

(5) That if the quantity of acid found in the urine in a case of suspected poisoning be in excess of this amount, it constitutes important confirmatory evidence.

Lastly, dialysis may be resorted to for the purpose of extracting the acid from organic liquids.

The *stains* produced by the acid on black cloth are red, but are nothing like so intense in colour as those produced by sulphuric acid. They disappear in the course of time, on account of the volatility of the acid. For the detection of the acid in stains, it is merely necessary to boil a given weight of the stained cloth in water, and precipitate the filtered solution with nitrate of silver, testing a similar quantity of the unstained portion for purposes of comparison.

Cases of Poisoning by Hydrochloric Acid.

<table>
<tr><td colspan="3">1.
"Lancet," July 16, 1859, p. 59. Female: æt. 63. ℥ss.</td></tr>
<tr><td><i>Symptoms.</i>—Immediate.</td><td><i>Result.</i>—Death in 18 hours.</td><td><i>Post-mortem.</i>—Mouth and throat white; no perforation of the stomach.</td></tr>
<tr><td colspan="3">2.
"Lancet," July 27, 1850, p. 113 (Dr. David Price). Male: æt. 30. About ℥j.</td></tr>
<tr><td><i>Symptoms.</i>—Almost immediate ptyalism; hiccup; motions very black; pain very severe; (stomach-pump used.) Recovery in 9 days.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">3.
"Lancet," March 7, 1840, p. 899 (Mr. Crawford). Female: æt. 40. A mixture of ℥j of acid, with ℥j of "<i>tincture of steel</i>," and also said to contain some corrosive sublimate. This, however, is doubtful.</td></tr>
<tr><td><i>Symptoms.</i>—Vomiting, but no pain or heat in mouth, throat, or epigastrium; no thirst. Death in 5½ hours.</td><td><i>Result.</i>—Death in 5½ hours.</td><td><i>Post-mortem.</i>—Blood in heart black and fluid; mucous membrane of stomach easily peeled off; no perforation; lower part of œsophagus appeared charred.</td></tr>
<tr><td colspan="3">4.
"British Medical Journal," March 4, 1871, p. 221 (Dr. G. Johnson). Female: æt. 15. ʒj of hydrochloric acid.</td></tr>
<tr><td><i>Symptoms.</i>—No stains round the mouth; mucous membrane of throat and mouth of a white or ash grey colour; great thirst, but no special pain or abdominal tenderness; rallied for a little while, but shortly afterwards became worse; tracheotomy had to be performed; epiglottis white, swollen, and corroded. Remained sensible; suffered very little pain.</td><td><i>Result.</i>—Death in 10 hours.</td><td><i>Post-mortem</i> in 20 hours. Mouth, fauces, pharynx, and œsophagus of an ash grey colour; epithelium easily stripped off, when a red congested surface appeared underneath; mucous membrane of the stomach black, but not destroyed; no perforations; cardiac end most injured, but no injury apparent beyond the pylorus.</td></tr>
<tr><td colspan="3">5.
"Medical Times and Gazette," July 5, 1856, p. 20 (Dr. Deutsch). From "Berlin Zeitung," 1855. Male: æt. 30. (Quantity?)</td></tr>
<tr><td><i>Symptoms.</i>—Fell to the ground immediately; vomiting of a yellowish-green fluid; convulsions.</td><td><i>Result.</i>—Death in 2 hours.</td><td><i>Post-mortem.</i>—Tongue and mouth unchanged in appearance; pharynx dark brown; œsophagus normal; muscular coat of stomach very firm, but congested, with black spots in places.</td></tr>
<tr><td colspan="3">6.
"Medical Times," Oct. 9, 1841, p. 15. Male: adult. Half a teacupful of a solution of tin in H Cl.</td></tr>
<tr><td><i>Symptoms.</i>—Pain, thirst, vomiting of thick glairy mucus. Delirium.</td><td><i>Result.</i>—Death on the third day.</td><td><i>Post-mortem.</i>—Œsophagus somewhat inflamed, and stomach violently so; a few inches only of the duodenum appeared congested.</td></tr>
</table>

For other Cases of Poisoning by Hydrochloric Acid, see:—

"Bull. Gén. de Thérap.," Oct. 20, 1872, p. 364 (Dr. Paul).
"Arch. d. Heilk," 1872, p. 213 (Dr. Nager).
"Guy's Hospital Reports," Oct., 1850, p. 211.
"Medical Gazette," Dec. 28, 1849.

HYDROFLUORIC ACID (H F).

Hydrofluoric acid is prepared by distilling fluor-spar (CaF_2) with sulphuric acid in a platinum vessel. Its chief use is for the purpose of glass-etching. Its action is intense when applied to the skin, cauterizing it with great rapidity, and producing a painful and slow-healing sore.

Its action on glass constitutes its chief test.

One case of death from ½ oz. of the acid is recorded. The man only lived for 35 minutes.

Case of Poisoning with Hydrofluoric Acid.

"Lancet," Feb. 8, 1873, p. 203 (Dr. King). Male: æt. 46. ℥ss.		
Symptoms.—Vomiting and violent pain. Death.	*Result.*—Death in 35 minutes.	*Post-mortem.*—Blood acid; lungs congested; mouth white, and the epithelium stripped off; parts of œsophagus whitened; parts of the coats of the stomach blackened and the stomach itself full of blackish fluid. No erosion. The epiglottis was denuded.

NITRO-SULPHURIC ACID.

Nitro-sulphuric acid consists of a mixture of strong nitric acid and oil of vitriol. It is largely used in the fabrication of gun-cotton, and is consequently not uncommonly in the hands of the public. The usual proportions in which it is mixed for this purpose are two parts by measure of the strongest sulphuric acid (sp. gr. 1850), and one part of fuming nitric acid (sp. gr. 1450).

It is a heavy colourless liquid. Its specific gravity is greater than the mean of the two acids used in its preparation. Dense white fumes are given off from it.

A great rise of temperature is produced when the acid is mixed with water. It attracts moisture from the air, and also abstracts it from organic bodies with which it may be brought into contact.

Ordinary metals, such as zinc, iron, and lead, are rapidly attacked either by the dilute acid, or by the strong acid when heated, but only very slowly by the concentrated acid in the cold.

Sulphur, phosphorus, iodine, &c., are rapidly acted upon by it.

Organic bodies are attacked by it in some cases with great energy, deep red fumes being given off, whilst in other cases the action is very slow, compounds being formed that are more or less explosive.

White cane sugar is gradually dissolved by it, the liquid becoming brown, and the sugar after a time separating as a resinous solid. This substance, when well washed in water, becomes a hard, silky, silver coloured body having a bitter taste. If heated it explodes like gunpowder, leaving a mere trace of ash. It is insoluble in cold water, but soluble in alcohol and ether.

Manna forms with it an explosive body. It has been proposed that this compound should be used for percussion caps.

Its action on *glycerine* is energetic at *ordinary* temperatures, whilst at a *low* temperature the glycerine is merely dissolved. On pouring this solution into water a heavy oily liquid separates, which is sweet, pungent, and very poisonous (nitro-glycerine, or glonoin [$C_3\ H_5\ (NO_2)_3\ O_3$.])

Starch forms with the acid a white explosive pulverulent solid. If any gluten be present, the mass turns of a yellow colour.

Cotton or linen cloth does not appear at first to be acted upon by the acid, but increases from 70 to 75 per cent. in weight, and becomes very explosive (Schönbein, 1846). The gases given off (in quantity about 1 cub. in. for every 0·5 grain of the cloth acted upon), are very deleterious, and consist of carbonic oxide, carbonic acid, cyanogen, nitric oxide, &c., in the following proportions :—

Carbonic oxide	35·7	per cent.	
Carbonic acid	14·3	,,	
Nitrogen	7·2	,,	
Nitric oxide	35·7	,,	
Cyanogen	7·1	,,	= 100·00.

Wood tar, resinous matters, &c., acted on by the acid, turn a dark colour, the washed residue being somewhat explosive.

Most of the *hydrocarbons* are acted upon by it energetically, and most *colours* are discharged by it.

Animal substances.—Albumen is coagulated and turned yellow. Mucous membranes are first whitened, and then assume a yellow tint. Animal substances generally, become a pulpy rotten mass when heated with it.

Tests.

They are those already described under the heads of the two acids. If the mixed acid be distilled the nitric acid will pass over first, and the sulphuric acid be left in the retort.

In a case of poisoning you would discover after death the special characteristic appearances of nitric acid poisoning. The urine should be particularly examined.

NITRO-HYDROCHLORIC ACID (Aqua Regia).

This is usually made by mixing two or three parts of hydrochloric acid with one of nitric.

The acid has generally a slightly yellow colour and fumes when exposed to the air. It has a suffocating odour, and either boils, or is decomposed at a temperature a little below 100° Cent. It has a density the mean of the acids used in its preparation.

It is not a very permanent body, the hydrogen of the one acid re-acting on the oxygen of the other, by which means chlorine and nitrous acid are produced. In an open vessel this action goes on until one or other of the acids is entirely destroyed. It is a powerful oxidizing agent.

Iodine, phosphorus, sulphur, and selenium, and the metals generally, are rapidly oxidized by it. Vegetable substances are also rapidly attacked by the acid, and if the mixture be heated a product will be left, containing oxalic acid. Albumen is coagulated and turned yellow by it. Animal matters are dissolved by the hot acid, red fumes being evolved.

The tests for the acid, in addition to those already described under the heads of the separate acids, are—

1. Its property of dissolving the noble metals.
2. The evolution of chlorine and nitric oxide.

It must be borne in mind, however, that if the acid has been long exposed to the air, or boiled in an open vessel, it may then lose both these properties.

SULPH-INDIGOTIC ACID.

(Sulphate of Indigo.)

This is nothing more than indigo dissolved in sulphuric acid. The existence of a *blue* vomit may point to arsenic having been administered, indigo being one of the substances required by law to be mixed with small quantities when sold retail. Still, occasional cases of poisoning by sulph-indigotic acid are said to have occurred. All the excretions will be found to be coloured blue. The symptoms and treatment are similar to those already described under the head of sulphuric acid.

CHAPTER XII.

VEGETABLE POISONS.

Poisonous Plants and their Active Principles.

1. AMARYLLIDACEÆ.—*Narcissus Pseudo-Narcissus* (*Daffodil*).
2. ANACARDIACEÆ.—*Rhus Radicans. R. Toxicodendron. R. Vernix.*
3. APOCYNACEÆ.—*Nerium Oleander.*
4. AQUIFOLIACEÆ.—*Ilex Aquifolium* (*Holly*).
5. AROIDEÆ.—*Arum Maculatum* (*Cuckoo Pint*).
6. ARTOCARPACEÆ.—*Upas Antiar.*
7. CAPRIFOLIACEÆ.—*Sambucus Nigra* (*Elder*). *S. Edulus. Viburnum Opulus.* (*Guelder Rose.*)
8. CINCHONACEÆ.—*Cephaelis Ipecacuhana* (*Ipecacuan*). *Cinchona barks. Quinine—Quinoidine.*
9. COMPOSITÆ.—*Artemisia Absinthium* (*Wormwood*). *Caltha Palustris* (*Marsh Mangold*). *Lactuca Sativa* (*Lettuce*).
10. CONIFERÆ.—*Juniperus Sabina* (*Savin*). *Taxus Baccata* (*Yew*).
11. CONVOLVULACEÆ.—*Convolvulus Scammonea* (*Scammony*). *Exogonium Purga* (*Jalap*).
12. CORIARIACEÆ.—*Coriaria Myrtifolia* (*Myrtle-leaved Sumach*).
13. CUCURBITACEÆ.—*Bryonia Dioica* (*White Bryony*). *Cucumis Colocynthis* (*Colocynth*). *Ecbalium Officinarum* (*Elaterium*).
14. DIOSCOREACEÆ.—*Tamus Communis* (*Black Bryony*).
15. EUPHORBIACEÆ.—*Croton Tiglium. Euphorbia Officinarum* (*Spurge*). *Hippomane Mancinella. Jatropha Curcas* (*Physic Nut*). *Ricinus Communis* (*Castor Oil*).
16. FUNGALES.—*Poisonous Fungi. Secale Cornutum* (*Ergot*).
17. GUTTIFERÆ.—*Garcinia Morella* (*Gamboge*).
18. GRAMINACEÆ.—*Lolium Temulentum* (*Bearded Darnel*).
19. LAURACEÆ.—*Camphora Officinarum.*
20. LEGUMINOSÆ.—*Arachis Hypogæa. Cytisus Laburnum* (*Laburnum*). *Physostigma Venenosum* (*Calabar, or Ordeal Bean*).
21. LILIACEÆ.—*Aloe Vulgaris. Squilla Maritima* (*Squill*).
22. LOBELIACEÆ.—*Lobelia Inflata* (*Indian Tobacco*).
23. LOGANIACEÆ.—*Gelsemium Sempervirens* (*Yellow Jasmine*). *Strychnos Nux Vomica.*
24. MELANTHACEÆ.—*Asagræa Officinalis. Colchicum Autumnale* (*Autumn Crocus*). *Veratrum Album. Veratrum Viride.*
25. MENISPERMACEÆ.—*Menispermum Cocculus.*
26. OLEACEÆ.—*Ligustrum Vulgare* (*Privet*).
27. PAPAVERACEÆ.—*Papaver Somniferum* (*Poppy*).
28. RANUNCULACEÆ.—*Aconitum Napellus* (*Aconite, Monkshood*). *Anemone Pulsatilla, &c. Delphinium Staphysagria* (*Stavesacre*). *Helleborus Nigra* (*Christmas Rose*). *H. Fœtidus, &c. Ranunculus Acris* (*Buttercup*), *&c.*

29. RUTACEÆ.—*Ruta Graveolens* (*Rue*).
30. SCROPHULARIACEÆ.—*Digitalis Purpurea* (*Foxglove*).
31. SOLANACEÆ.—*Atropa Belladonna* (*Deadly Nightshade*). *Capsicum Fastigiatum* (*Cayenne*). *Datura Stramonium* (*Thornapple*). *Hyoscyamus Niger* (*Henbane*). *Nicotiana Tabacum* (*Tobacco*). *Solanum Dulcamara* (*Woody Nightshade*). *Solanum Nigrum. Solanum Tuberosum.*
32. THYMELACEÆ—*Daphne Mezereum* (*Mezereon*), *&c.*
33. UMBELLIFERÆ.—*Æthusa Cynapium* (*Fool's Parsley*). *Cicuta Virosa* (*Water Hemlock*). *Conium Maculatum* (*Hemlock*). *Œnanthe Crocata* (*Dropwort*). *Phellandrium Aquaticum.*

Before proceeding to examine the several poisonous plants in detail, it may be well to state that in conducting a medico-legal enquiry in cases of poisoning by their agency, we should, having first of all strained off the liquid portions through a piece of muslin, carefully search in the solid contents of the stomach and intestines for any portions of stems, roots, leaves, flowers, fruit, and more particularly of seeds, and examine these for any special botanical characters they present, that may serve for the purpose of their identification. Such examination is best made by placing the solid materials on a white plate and by using a large hand magnifying glass and a scalpel.

When this is done we should proceed to endeavour to extract the active principle of the plant from the contents of the stomach and intestines.

In most cases, and where we have given no special directions to the contrary, we recommend for this purpose the process we shall now describe :—In a few cases it is either unsuitable, or other processes are preferable. In certain investigations, such as an examination in a case of poisoning by morphia or strychnia, we have described the various methods suggested by various authorities. This was necessary from the more than usual importance of these and of some other alkaloids.

Place the contents of the stomach and intestines in a clean wide-mouthed bottle, and having rendered them acid with a few drops of acetic or hydrochloric acid, treat them with a considerable quantity of alcohol and put them aside for some hours in a warm place, occasionally giving the bottle a shake. Filter the materials through thick blotting-paper, and treat the filtrate with an excess of subacetate of lead (Goulard's Extract), and filter off the precipitate formed.

Sulphuretted hydrogen must now be passed through the clear filtrate until the liquid shows by its action on lead-paper that complete saturation has been effected. In this way any excess of lead added will be thrown down and may be filtered off. Evaporate the clear filtrate to dryness and dissolve the residue in a few drops of water acidulated with acetic acid. It may be necessary to filter this. Super-saturate this alcoholic extract with bicarbonate of potash, and extract from this the alkaloid either by ether or chloroform in the manner already indicated (page 63).

The tasting the residues from time to time should never be neglected, whilst in all cases the physiological action on a frog of the ethereal or chloroform residue should be tried and noted.

1. AMARYLLIDACEÆ.

Narcissus Pseudo-Narcissus.

(Daffodil—Meadow Narcissus.)

Orfila states that he found that four drams of the aqueous extract of this plant secured in the stomach of a dog killed it in twenty-four hours, whilst one dram placed in a wound destroyed life in six hours.

It acts as an irritant poison. The rectum was invariably found to be much inflamed.

2. ANACARDIACEÆ.

Rhus Radicans (Poison-Oak—Poison-Ivy.) *R. Toxicodendron. R. Vernix.*

The milky juice of these plants applied to the skin excites intense burning and itching. It is said that the mere handling the *R. Vernix* (poison-sumach), has caused blindness, whilst bad symptoms have been produced by its being burnt in an ordinary fire. Other varieties also act as irritant poisons.

3. APOCYNACEÆ.

Nerium Oleander.

This plant has been examined by Pelikan of St. Petersburg. Its true poisonous principle, he believes, is a yellow resinoid body.

Experimenting on frogs he found that—

1. When first administered it produces an acceleration of the heart's action.
2. After a few minutes the beats become less frequent.
3. Later on the pulsations become irregular and then cease entirely.
4. That at this time the ventricles of the heart are empty and inactive, but that the auricles continue to contract.
5. Finally the heart becomes completely paralysed.

Professor Pelikan considers its action very similar to that of digitalis.

4. AQUIFOLIACEÆ.

Ilex Aquifolium.

(Holly.)

Holly-berries act as a narcotico-acrid poison. The leaves have been said to prove beneficial in diseases of the urinary organs, as well as in jaundice, pleurisy, colic, &c.

Case of Poisoning by Ilex Aquifolium.

"Lancet," April 16, 1870, p. 573 (Mr. Barkas). Male: æt. 3. Numerous berries of common holly.		
Symptoms.—Vomiting, pain, purging; afterwards drowsiness and loss of consciousness. Recovery in 24 hours.	*Result.*—Recovery.	

5. AROIDEÆ.

Arum Maculatum.

(Arum—Cuckoo-pint—Lords and Ladies.)

The leaves of this plant are arrow-shaped, having an enclosed purple column, bearing a cluster of bright red berries.

The root is tuberous and very acrid.

It is an irritant poison, its poisonous properties being dissipated by heat.

"Portland Sago" is manufactured from the roots, which are first steeped in water, and then baked, and powdered.

Two leaves are sufficient to produce pain, vomiting, and diarrhœa (Christison).

Great local irritation, swelling of the tongue, convulsions, dilated pupils, insensibility and coma are usual symptoms.

The *A. Seguinum* (West Indies) furnishes a juice, two drams of which has proved fatal in a few hours.

Dr. Frazer advises in poisoning by the arum to give melted fresh butter, and after free vomiting is produced, strong coffee ("British Medical Journal," June 22, 1861, p. 654).

Cases of Poisoning with the Arum Maculatum.

1. Guy's "Forensic Medicine," p. 626. 3 children. The leaves.		
Symptoms.—The tongues of all the children became so swollen as to render swallowing difficult. Two children died in 12 and 16 days respectively. The third recovered.	*Result*—(2) Death in 12 and 16 days. (1) Recovery.	
2. "Lancet," April 13, 1872, p. 530 (Dr. Russell Steele). Male: æt. 43. One leaf taken for tape worm.		
Symptoms.—Immediate pain and pricking sensation in the mouth downwards; tongue became swollen; salivation; vomiting.	*Result.*—Recovery.	
3. "British Medical Journal," June 22, 1861, p. 654 (Dr. Frazer). Male: æt. 6.		
Symptoms.—Found in a kind of fit. Spasmodic action of all the muscles of the body; bloody froth at the mouth; pupils dilated; heart's action very feeble; rigid closure of the jaw. A certain drowsiness succeeded.	*Result.*—Recovery.	
4. "British Medical Journal," June 22, 1861, p. 654 (Dr. Frazer). Male: æt. 8.		
Symptoms.—Convulsions; pupils widely dilated.	*Result.*—Recovery.	

5. "British Medical Journal," June 22, 1861, p. 654 (Dr. Frazer). (Quoted from "Gazette Medica di Porto.") Æt. 3. Masticated the roots.		
Symptoms.—Immediate burning pain in mouth and lips; torpor in three hours, complete prostration in six hours; delirium; asphyxia.	*Result.*—Death in 9 hours.	
Another case is also recorded. "Medical Times and Gazette," June 6th, 1857. Death from eating leaves.		

6. ARTOCARPACEÆ.

Upas Antiar (*Antiaris Toxicaria*).

This is a Javanese poison. In small doses it acts as an irritant, but in large doses it induces coma and convulsions. It acts violently on the heart, which will be found immediately after death to have lost its irritability, and the left ventricle to contain florid blood. The poison has no action when merely applied to a nerve.

The plant contains a milky juice or extract, the active principle of which is a neutral body called *Antiarin.*

The *Upas Tieuté* (the Strychnos Tieuté [Loganiaceæ]), owes its poisonous action to strychnia and not to antiarin ("Medical Times and Gazette," May 16, 1863, p. 511; see also August 23, 1862, p. 203).

7. CAPRIFOLIACEÆ.

Sambucus Nigra. S. Edulus.

(Elder.)

Christison notes a case which occurred in his practice where the leaves and flowers of the elder produced in a boy the active symptoms, continuing for eight days, of an irritant poison.

The powdered root of the *S. Edulus* (dwarf elder) has proved fatal to a woman fifty-four years old in a dose of two table-spoonsful.

Viburnum Opulus.

(Guelder Rose.)

The berries of this plant have proved fatal, the symptoms produced being those of a narcotico-acrid poison. In one case death occurred in thirty-six hours.

Case of Poisoning by the berries of the Guelder Rose.

Taylor's "Medical Jurisprudence," vol. i., p. 448 (Mr. W. B. Smith). Five children eat the berries.		
Symptoms.—Coma; insensibility; pupils not much dilated; legs somewhat rigid. Death occurred in one case in 36 hours (female, æt. 5). The other children recovered.	*Result.*—Death in 36 hours of female æt. 5. Recovery in other cases.	*Post-mortem.*—No inflammation of stomach or intestines. Brain slightly congested on the surface.

8. CINCHONACEÆ.

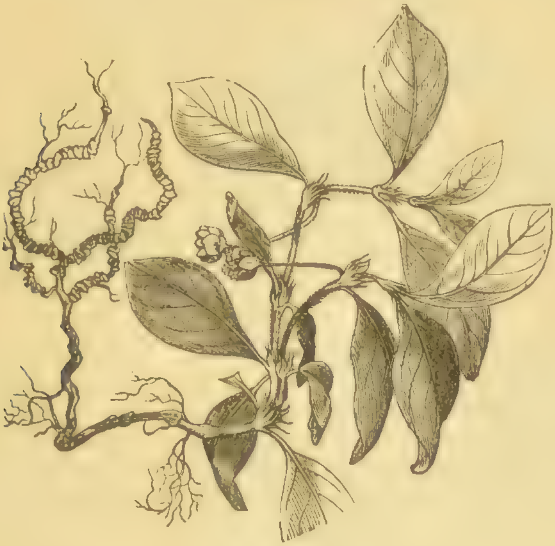
Cephaelis Ipecacuanha.

(Ipecacuan or Ipecacuanha.)

Ipecacuan is a powerful emetic, and in large doses proves dangerous. Serious symptoms of great distress of breathing, vomiting, with even slight convulsions have been frequently produced by the odoriferous effluvia given off from the drug.

The alkaloid, to which it owes its action, called *emetia* or *emetine* ($C_{30}H_{44}N_2O_8$) is a powerful poison. Two grains will kill a dog in fifteen to twenty-four hours, vomiting and coma being the chief symptoms that are produced.

FIG. 25.



We may regard Ipecacuanha as a narcotico-acrid poison. Our colleague, Mr. Rodgers, has seen several cases of severe symptoms, produced by its internal administration.

Cinchona Barks.

(Quinine: Sulphate of Quinoidine.)

In a case that was referred to one of the authors (Dr. Tidy) by Mr. Lewes, the Coroner for Essex, two ounces of a strong solution of sulphate of quinoidine (eighty-five grains to the oz.), kept in stock by a large quinine manufacturer for dilution as an "ague mixture," to give his workpeople, was taken by mistake for a black draught. The man died in half-an-hour. We have no record of any symptoms. The brain, according to Mr. Kennedy, who made the post-mortem, was much congested, the vessels being filled with dark-coloured blood. The stomach was somewhat inflamed and contained about four ounces of a bitter fluid which exactly corresponded with the mixture the deceased was reported to have swallowed ("Lancet," July 13, 1872, p. 41).

M. Desiderio records that when large doses of sulphate of quinine are given to dogs, it produces sleep, giddiness, and defective vision. Bleeding and prussic acid were found to relieve the symptoms ("Lancet," April 5, 1845, p. 374). M. Malier has also made experiments with quinine on dogs, and has recorded certain poisonous effects that he has seen produced ("Lancet," July 27, 1844). Dr. Baldwin states that he has seen blindness, convulsions, and death result from quinine, and he regards 60 to 80 grains as a poisonous dose ("Medical Times," July 10, 1847, p. 397).

In the tropics, however, as much as 120 grains have been given without bad effects. It may be doubted if death has ever resulted from quinine alone.

9. COMPOSITÆ.

Artemisia Absinthium and other species.

(Wormwoods.)

Severe symptoms have resulted from the taking half an ounce of the oil of wormwood. It is a narcotico-acrid poison.

Absinthe, a favourite French liqueur, owes its poisonous action to the oil of wormwood that it contains. It is a mixture of several aromatic oils with spirit. Its effects when taken in excess seem to be terrible—giddiness, illusions, muscular weakness, loss of intellect, paralysis, and above all, epileptiform convulsions conjoined with delirium tremens being not uncommon.

The experiments of French physicians on animals deserve a passing notice ("Lancet," March 6, 1869, p. 334). They show that animals exposed to the action of the vapours of oil of wormwood experience first excitement, and then epileptiform convulsions, whilst experiments made similarly and side by side with the vapour of alcohol, merely rendered the animals intoxicated. These experiments indicate that probably absinthe poisoning differs materially from alcoholic intoxication.

Case of Poisoning by Oil of Wormwood.

"Medical Times and Gazette," Dec. 6, 1862, p. 613 (Dr. Wm. Smith). Male adult: ℥ss of oil of wormwood.		
Symptoms.—Found early one morning insensible, convulsed, and foaming at mouth. Convulsions passed off; jaws became clenched; pupils dilated; pulse slow and weak; attempted to vomit and to talk. After vomiting was induced, consciousness partially returned. After recovery he had forgotten all about it.	*Result.*—Recovery.	

Caltha Palustris.

(Marsh Marigold.)

Severe symptoms (Rust's "Magazine," xx. 451), were caused in a family of five persons from eating the plant. It has an acrid taste (Wibmer and Haller). The symptoms induced in the cases mentioned were pain, vomiting, diarrhœa, and an eruption of pemphigous vesicles. In this country the marsh marigold can scarcely be regarded as a dangerous plant.

Lactuca Sativa (Ordinary Lettuce)
Lactuca Virosa (Strong-scented Lettuce).

The lettuce is a narcotic poison. The L. Virosa is more energetic in its action than the L. Sativa.

The inspissated juice (Lactucarium) of the lettuce is more active than the extract. The juice is at first milky, but afterwards dries up to a brown mass. It is very bitter (due to Lactucia), and has an opium odour, but does not give the opium reactions.

10. CONIFERÆ.

Yew and savin are the only two poisonous plants of the order Coniferæ growing in this country. The one may easily be distinguished from the other by the peculiar odour developed when savin is submitted to friction, and by the absence of any smell when the yew is subjected to a similar process.

Juniperus Sabina.
(Savin.)

Savin is a bushy shrub, having a round purple currant-like fruit. All parts of the plant have a strong odour and an acrid taste. It is an irritant poison, and owes its action to the presence of an essential oil which may be obtained by distillation from the fresh tops of the shrub.

It is rarely taken as a poison, but is frequently both taken and given for the purpose of procuring abortion.

The experiments on animals with savin are important.

Dose.	Animal.	Symptoms.	Post-mortem.
ʒij of powdered savin (Dr. Letheby).	Dog.	Drowsiness in 1 hour; vomiting came on in 1½ hours, after which the dog went to sleep. Two hours afterwards it was found in the same position, quite comatose, the breathing "puffy," the pupils contracted, the action of the heart slow and laboured, but the limbs moving when pinched. For 8 hours it lay in this state, passing blood involuntarily by stool, occasional convulsive movements of the hind legs being noted; the breathing became slower and slower; and death occurred in 14 hours after taking the poison.	Vessels on surface of brain congested and filled with dark blood; the brain itself somewhat congested; lungs collapsed and of a bright scarlet colour; right cavities of the heart full — the left empty; liver and spleen congested; stomach and upper part of the small intestines very pale externally—the lower part of intestines being very congested and highly vascular internally; the stomach was pale, excepting in two or three spots, where the mucous coat was injected with blood; it contained a dark brown fluid, yielding a turbid liquid on distillation, from which savin oil was obtained.
ʒvi of the powdered leaves (Orfila).	Dog.	Injected into the stomach, and secured by a ligature; death in 16 hours.	Redness of the rectum.
ʒij of the powdered leaves (Orfila).	Dog.	Placed in a wound; death on the second day.	Redness of the lower bowels.

Oil of Savin.

($C_{10}H_{16}$; isomeric with oil of turpentine.)

The oil is either colourless or of a pale yellow tint (sp. gr. 0·915), and has a peculiar odour and taste.

Symptoms. Time of Death.

The symptoms are not immediate in their appearance. They generally consist of pain, vomiting, violent straining at stool, followed by coma. Salivation has been recorded. Abortion (if the patient be pregnant) may or may not occur. Death may be delayed for several days, whilst it may take place in as soon as fifteen or sixteen hours after the poison has been swallowed. The cases on record do not state the doses that caused death.

It has also been given for worms, but is a dangerous medicine.

Post-Mortem Appearances.

Congestion of the venous and capillary system have been generally found, the blood being black and the heart full, especially on the right side. Savin exerts a specific action upon the vessels of the lower bowel, rendering it turgid and inflamed. And this is the true action of savin with respect to its supposed abortive power and its influence in urging on the menstrual flow. It is only natural that the vessels of the uterus should participate in the general plethora of the intestinal system. Vogt states that it has a tendency to produce an apoplectic condition of the fœtus, and this indeed appears to be highly probable. No doubt, therefore, if a woman has a tendency to miscarry, the intestinal irritation and the constitutional injury occasioned by savin will materially aid it. But on the other hand, it may and often does fail. Foderé relates one case where a woman took 100 drops of the oil daily for twenty days without effect, and a second where a large dose of the powder was taken by a pregnant woman, and although violent poisoning symptoms were produced, abortion did not result.

Savin, however, is strongly believed in by the vulgar, and its discovery, therefore in the stomach after death affords ground for serious suspicion.

Toxicological Analysis.

In a medico-legal investigation the contents of the stomach, if powdered savin has been taken, will probably be found of a green colour, whilst the coniferous structure of the herb will be recognised by the microscope. The organic matters must then be distilled, when a *turbid* fluid will come over, smelling and tasting like oil of savin. This is to be shaken up with ether, when the liquid will immediately clear. The ether must then be decanted and allowed to evaporate spontaneously, when the oil of savin dissolved by the ether will remain behind, and may be recognised by its peculiar odour and taste. The residue in the retort should then be digested with ether, when a green solution, consisting of resin and chlorophylle, will be obtained.

The odour of the herb is developed by friction, as by rubbing it in a mortar. The watery solution strikes a deep green with permuriate of iron.

Cases of Poisoning by Savin.

<table>
<tr><td colspan="3">1.
"Medical Gazette," vol. xxxvi., p. 646. Female. Quantity (?).</td></tr>
<tr><td><i>Symptoms.</i>—Abortion first took place, and afterwards death.</td><td><i>Result.</i>—Death.</td><td><i>Post-mortem</i> —Stomach and intestines very inflamed. Portions of savin found on examination.</td></tr>
<tr><td colspan="3">2.
"Lancet," 1845, vol. i., p. 677 (Dr. Letheby and Mr. Newth). Female: æt. 21. Pregnant; seventh or eighth month. Quantity (?).</td></tr>
<tr><td><i>Symptoms.</i>—After a few hours had violent pain and sickness, and then became insensible. After a time stertorous breathing came on, with foaming at mouth, and convulsions. The uterus in 12 hours was acting vigorously, each contraction being accompanied with convulsive tremor. Four hours afterwards, as the labour was progressing, she gave a low moan, and died.</td><td><i>Result.</i>—Death in 16 hours.</td><td><i>Post-mortem.</i>—Vessels on surface of brain gorged, and brain itself inflamed; stomach almost natural, except in one or two spots, which were red. Savin found.</td></tr>
<tr><td colspan="3">3.
"Christison," p. 606 (Mr. Cockson). Female. Infusion of savin leaves taken in two doses to produce abortion.</td></tr>
<tr><td><i>Symptoms.</i>—Pain. The following day she miscarried, and four days afterwards died.</td><td><i>Result.</i>—Death in 4 days.</td><td><i>Post-mortem.</i> — Extensive peritoneal inflammation; stomach very red, contents being green, and containing portions of savin.</td></tr>
<tr><td colspan="3">4.
"Christison," p. 606 (Dr. Traill). Female. Powdered savin.</td></tr>
<tr><td><i>Symptoms.</i>—Pain, vomiting, straining at stool, great fever, and death after several days.</td><td><i>Result.</i>—Death after several days.</td><td><i>Post-mortem.</i>—Stomach inflamed, and in parts black and perforated; intestines also inflamed. Savin powder detected after death.</td></tr>
<tr><td colspan="3">5.
"Wibmer." Female. Infusion.</td></tr>
<tr><td><i>Symptoms.</i>—Violent vomiting.</td><td><i>Result.</i>—Death.</td><td><i>Post-mortem.</i>—Death caused by bursting of gall-bladder from violent vomiting.</td></tr>
<tr><td colspan="3">6.
"Foderé," vol. iii., p. 431. Female. Powdered savin. Seven months pregnant.</td></tr>
<tr><td><i>Symptoms.</i>—Hiccup and vomiting, followed by a fever lasting 15 days, from which she recovered. After two months was confined of a healthy child.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">7.
"Lancet," July 13, 1872, p. 41 (Dr. Tidy). Female.</td></tr>
<tr><td><i>Symptoms.</i> —Convulsions. Symptoms very like strychnia.</td><td><i>Result.</i>—Death.</td><td></td></tr>
<tr><td colspan="3"><i>The following case of poisoning by savin is also recorded.</i>
"Medical Times and Gazette," Sept. 28, 1850, p. 344. (Death. Female: æt. 34).</td></tr>
</table>

Taxus Baccata.

(Yew.)

The *leaves* of the yew are lancet-shaped. The *berries* are about the size of a pea, and are contained in two capsules, one being of a light red color, and open at the top, exposing a brown capsule underneath. This contains a thick colourless juice, which is very acrid and nauseous both to taste and smell. The yew is a narcotico-acrid poison, and its action on animals generally is severe and rapid (case of Wilson *v.* Newbury). It is vulgarly but erroneously supposed that the fresh leaves are inert.

Two ounces of the juice of the leaves was found to prove fatal to a dog, whilst thirty-six grains of the extract when injected into the jugular vein caused death, with giddiness and stupor (Orfila).

In the human subject the leaves and berries have both proved fatal, in times varying from less than one hour to nineteen hours. Vomiting, convulsions, and coma are the prominent symptoms recorded. Recovery is rare.

It has been administered as a cure for worms, and has likewise been given and taken from its supposed power of producing abortion. (Yew-tree tea.) The nature of the yew-poison is not exactly known, but experiments lead to the belief that the active principle exists in a larger quantity in the seeds than in the other parts of the plant ("Lancet," Oct. 24, 1868, p. 560).

Cases of Poisoning with Yew.

<table>
<tr><td colspan="3">1.
"Provincial Journal," Nov. 29, 1848, p. 662. Female: æt. 5. Berries.</td></tr>
<tr><td>*Symptoms.*—Coma.</td><td>*Result.*—Death in 4 hours.</td><td></td></tr>
<tr><td colspan="3">2.
"Provincial Journal," Dec. 27, p. 708. Male: æt. 4. Berries.</td></tr>
<tr><td>*Symptoms.*—Immediate vomiting, purging, coma, convulsions, dilated pupils, small pulse.</td><td>*Result.*—Death in 19 hours.</td><td></td></tr>
<tr><td colspan="3">3.
"Dublin Hospital Gazette," May 15, 1845, p. 109 (Dr. Mollan). Male adult (lunatic). Chewed the leaves.</td></tr>
<tr><td>*Symptoms.*—Rapid giddiness, vomiting, prostration, spasms, with irregular action of the heart.</td><td>*Result.*—Death in 14 hours.</td><td>*Post-mortem.*—Stomach distended.</td></tr>
<tr><td colspan="3">4.
"Lancet," Oct. 1, 1870, p. 471. Female: æt. 19. Decoction of leaves, taken for 4 consecutive mornings, to bring on catamenia.</td></tr>
<tr><td>*Symptoms.*—Death eight hours after the last dose. Intense narcotism. Vomiting and delirium.</td><td>*Result.*—Death in 8 hours.</td><td>*Post-mortem.*—No post-mortem peculiarities.</td></tr>
<tr><td colspan="3">5.
"Taylor's Medical Juris.," vol. i., p. 446 (Dr. Proctor). Female adult. About a teaspoonful of the leaves.</td></tr>
<tr><td>*Symptoms.*—After some hours became insensible, and died in a state of collapse three hours after the first symptoms.</td><td>*Result.* — Death after several hours.</td><td></td></tr>
<tr><td colspan="3">6.
"Taylor's Medical Juris.," vol. i., p. 447 (Mr. Hurt, of Mansfield). Æt. 3½. A quantity of yew leaves.</td></tr>
<tr><td>*Symptoms.*—Vomiting in one hour. No pain. Convulsions, and rapid death. In the first instance seemed to want to sleep.</td><td>*Result.*—Death rapid.</td><td>*Post-mortem.*—Redness and softening of the stomach; inflammation of small intestines.</td></tr>
</table>

<table>
<tr><td colspan="3">7.
"Medical Times and Gazette," 1870, vol. ii., p. 446. Male. Berries.</td></tr>
<tr><td><i>Symptoms.</i>—Found dead sitting in his chair after seven hours.</td><td><i>Result.</i>—Death in 7 hours at most.</td><td><i>Post-mortem.</i>—Right cavities of heart distended with fluid blood; stomach and small intestines red and softened; liver congested.</td></tr>
<tr><td colspan="3">8.
"Rust's Magazine," vol. xxiii., p. 374 (Dr. Hartmann). Female. Decoction taken to procure abortion.</td></tr>
<tr><td><i>Symptoms.</i>—Died without miscarriage.</td><td><i>Result.</i>—Death.</td><td></td></tr>
<tr><td colspan="3">9.
"Beck's Medical Juris.," p. 885 (Dr. Percival). Three children: æt. 5, 4, 3. Fresh leaves given for worms.</td></tr>
<tr><td><i>Symptoms.</i>—Yawning, listlessness. The eldest child vomited a little, and had pain, but the others had none. Death occurred in all within a few hours of each other.</td><td><i>Result.</i>—Death.</td><td></td></tr>
<tr><td colspan="3">10.
"Lancet," Oct. 17, 1868, p. 530 (Dr. James Thompson). Male: æt. 3. Berries.</td></tr>
<tr><td><i>Symptoms.</i> — Convulsions; patient became semi-comatose; vomiting; dilated pupils.</td><td><i>Result.</i>—Death in 4 hours.</td><td><i>Post-mortem.</i>—Liver and stomach congested.</td></tr>
<tr><td colspan="3">11.
"British Medical Journal," June 17, 1871, p. 643 (Mr. Wallis). Female: æt. 17. Yew leaves.</td></tr>
<tr><td><i>Symptoms.</i>—Death very sudden. Pupils slightly dilated.</td><td><i>Result.</i>—Death rapid.</td><td><i>Post-mortem.</i>—Heart normal; stomach inflamed, and contained yew leaves.</td></tr>
</table>

11. CONVOLVULACEÆ.

Convolvulus Scammonea.

(Scammony.)

The resin of the scammony is usually obtained from the root by its solution in rectified spirit, and is therefore free from admixture with gum. The natural scammony is prepared by allowing the juice to flow from incisions in the root, and this generally contains as much as 10 to 20 per cent. of gum.

Scammonin ($C_{32} H_{52} O_{16}$), the active principle of the plant is a glucoside.

Scammony is generally regarded as an irritant poison. Orfila, however, questions this, and asserts that he has found dogs live after taking four drams, no symptom other than purging being produced.

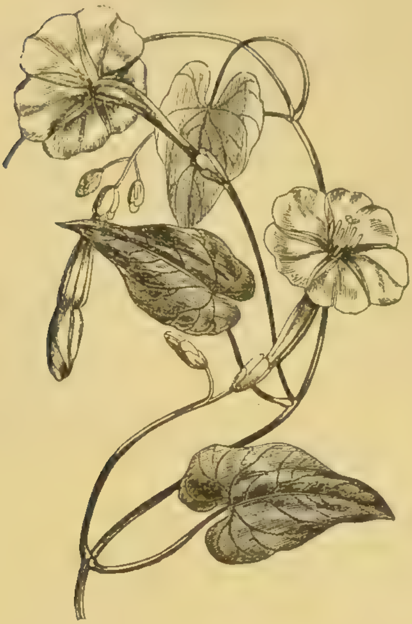
Exogonium Purga (Fig. 26.)

(Jalap). Mexico.

"Jalap" is the powdered tuber of the above plant. It contains about 10 to 15 per cent. of a resin which can be extracted by spirit, and also about 20 per cent. of starch, water and extractive matters.

The resin is insoluble in water or turpentine, partially soluble in ether, and very soluble in alcohol. It turns crimson when treated with sulphuric acid.

FIG. 26.



An acid (Jalapic Acid $C_{62} H_{106} O_{25}$), is present in that portion soluble in ether. It also contains two active bodies, jalapine and convolvulin.

Jalapine ($C_{31} H_{50} O_{16}$).

Jalapin is the true active principle of the jalap. It is soluble in ether. Sulphuric acid changes it yellow, the colour turning to an orange or reddish brown when heated. Acted on with nitric acid it changes yellow.

Convolvulin ($C_{34} H_{56} O_{16}$).

Convolvulin is found chiefly in the Mexican male jalap, and is insoluble in ether.

Jalap is an *irritant*, and in large doses an active poison. Two drams will kill a dog in four or five days. Death is caused by exhaustion from excessive purging.

12. CORIARIACEÆ.

Coriaria Myrtifolia.

(Myrtle-leaved Sumach.)

This plant is a narcotico-acrid poison. Fatal cases have occurred from the leaves having been employed as an adulterant of senna leaves. (See a case of serious symptoms from senna tea, "Lancet," Jan. 3, 1846, p. 28.) Death has been caused in an adult by fifteen of the berries. The symptoms that have been noted are a form of intoxication, with dilated pupils, tetanic convulsions and coma. Death has occurred within four hours, whilst it has been delayed for twenty-four.

Experiments on animals show that one dram of the extract of the juice will kill a cat in two hours, and that half a dram applied to a wound, will destroy life in eighty-five minutes. One grain injected into the jugular vein of a rabbit proved immediately fatal, death occurring in a single convulsive paroxysm. Given internally rabbits do not appear to be affected by it (Mayer, of Bonn). The post-mortem appearances show the brain intensely congested and the blood fluid.

The *C. Sarmentosa* (Toot plant of Australia and New Zealand) is exceedingly poisonous, although it is stated that old colonists, as well as native horses and cattle eat the plant with tolerable impunity.

Cases of Poisoning by Coriaria Myrtifolia.

1. “Mém. de l'Acad. des Sciences,” 1739, p. 47 (Sauvages). Child. Berries.		
Symptoms.—Epileptic convulsions.	*Result.*—Death in 1 day.	*Post-mortem.*—No post-mortem peculiarities.
2. “Mém. de l'Acad. des Sciences,” 1739, p. 47 (Sauvages). Adult. 15 berries.		
Symptoms.—Lividity of face, convulsions, coma. The berries were discharged after an emetic, but death took place the same day.	*Result.*—Death within 24 hours.	
3. “Journal de Chim. Méd.” vol. iv., 528 (M. Fée). Male, adult. Infusion of senna leaves that had been adulterated with coriaria, &c.		
Symptoms.—Colic, convulsions, lockjaw.	*Result.*—Death within 4 hours.	*Post-mortem.* — Inflammation of stomach and bowels.
4. “London Medical and Physical Journal,” April, 1829, vol. lxi., p. 292 (Roux). Æt. 3½. From 80 to 100 berries.		
Symptoms. — Intoxication, rolling of eyes, loss of voice, coma, lockjaw and convulsions; dilated pupils. Death.	*Result.*—Death in 16½ hours.	*Post-mortem.*—Injection of the membranes of the brain and spinal cord. No other special post-mortem appearances, except red patches in the intestines and stomach.
5. “London Medical and Physical Journal,” April, 1829, vol. lxi., p. 292 (Roux). 3 children.		
Symptoms.—All recovered after vomiting freely.	*Result.*—Recovery.	

13. CUCURBITACEÆ.

Bryonia Dioica.

(White Bryony or Wild Vine.)

The white bryony is commonly found in hedges climbing by tendrils. *The leaves* are rough, and the *flowers* small and of a green colour ; the *berries* are clustered (six seeds) and contain a very fetid juice—the *root* is spindle shaped, fleshy and pale, and is the most active part of the plant.

Bryony is a simple irritant poison.

It is said to contain an active principle called *bryonine,* 20 grains of which, injected into the pleura of animals, was found to cause death in seven hours. (Brandes and Firnhaber.)

One ounce of the root, secured in the stomach of a dog, killed it in twenty-four hours, and two and a half drams introduced into a wound proved fatal in sixty hours (Orfila). Vomiting, purging, and watery evacuations are the symptoms recorded.

The symptoms produced in the human subject are giddiness, intoxication, vomiting, diarrhœa, and coma. Death has occurred within four hours, and been delayed for thirty.

Cases of Poisoning with Bryony.

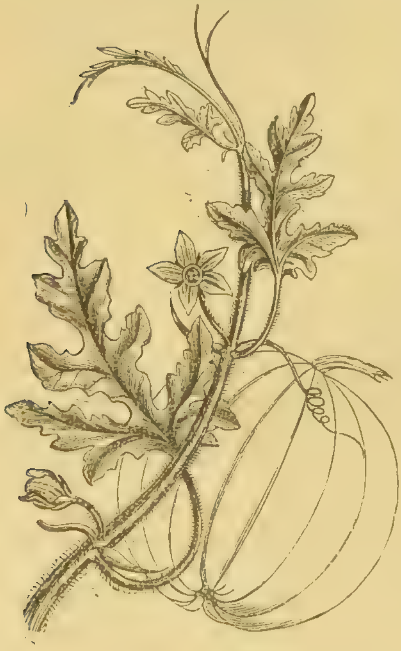
1. “Neues Magazin,” vol. i. part iii., p. 557 (Pyl). Male adult. Infusion of root taken as a cure for ague.		
Symptoms.—Purging.	*Result.*—Death.	

2. "Orfila Toxicologie," vol. i., p. 680. Female adult. Decoction of ℥j, part administered by mouth, and part used as an injection, taken to stop secretion of milk.		
	Result.—Death in 4 hours.	
3. "Lancet," May 9, 1868, p. 610 (Dr. Goate). Female: æt. 3. Berries.		
Symptoms.—Giddiness in half-an-hour; furious delirium during the night; vomiting; diarrhœa; and dilated pupils; afterwards coma.	*Result.*—Death in 30 hours.	

Cucumis Colocynthis (Fig. 27).
(Colocynth—Bitter Apple.)

The fruit is hard and yellow, about the size of an orange, somewhat porous, very bitter, and contains about 72 per cent. of seeds. It is usually met with in a dried and decorticated state.

FIG. 27.



Its active principle is *Colocynthin* ($C_{56} H_{84} O_{23}$ (?)) which is a glucoside, soluble in water and alcohol, but not in ether.

Three drams of colocynth, secured in the stomach of a dog, killed it in fifteen hours, whilst death was caused by two drams introduced into a wound (Orfila). In the experiments of the authors ʒiiiss proved fatal to three dogs in eighteen, twenty-two, and thirty-six hours respectively.

The symptoms produced by it in the human subject are those of an irritant poison.

A teaspoonful and a half of the powder has caused death, but recovery is recorded after swallowing as much as three ounces.

Death has occurred in one, two, and three days.

It is stated (Bocler) that those engaged in handling and triturating the pulp often suffer from violent purging.

Cases of Poisoning with Colocynth.

1. "Orfila Toxicologie," vol. i., p. 695. Male adult. ʒiij of colocynth taken for a gonorrhœa.		
Symptoms.—Vomiting, pain, diarrhœa, delirium. (Milk was administered, and leeches applied to the groin.)	*Result.*—Recovery.	

<table>
<tr><td colspan="3">2.
"Christison," p. 595. Female adult. A teaspoonful and a half of colocynth powder.</td></tr>
<tr><td><i>Symptoms.</i>—Vomiting, purging, and death.</td><td><i>Result.</i>—Death in 24 hours.</td><td></td></tr>
<tr><td colspan="3">3.
"Orfila Toxicologie," vol. i., p. 695 (M. Carron d'Annecy). Male adult. Decoction taken in two doses to cure piles.</td></tr>
<tr><td><i>Symptoms.</i>—Colic and purging; pain; afterwards the purging ceased, and retention of urine came on, with priapism, clammy sweats, and death.</td><td><i>Result.</i>—Death on the third day.</td><td><i>Post-mortem.</i> — Intestines red, with black spots; stomach here and there ulcerated; liver, kidneys, and bladder inflamed.</td></tr>
<tr><td colspan="3">4.
"Lancet," Feb. 1, 1868, p. 158 (Dr. Tidy). Female adult. ʒij to ʒiij of the powdered fruit.</td></tr>
<tr><td><i>Symptoms.</i>—Purging (stools bloody), and vomiting in a few hours. Death.</td><td><i>Result.</i>—Death in 40 hours.</td><td><i>Post-mortem.</i>—No post-mortem appearances specially to be remarked.</td></tr>
</table>

Ecbalium Officinarum (Fig. 28).

(Squirting or Wild Cucumber—Elaterium.)

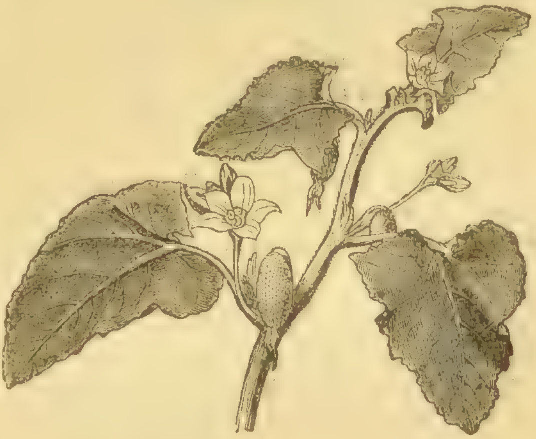
The fruit of the plant is about one and a half inches in length. What is known as "*Elaterium*" is the deposit that forms from the clear strained expressed juice of the fruit.

The active principle of the plant is *elaterine.* The quantity present in English elaterium varies from 15 to 26 per cent., whilst in French specimens it is not more than from 5 to 6.

Elaterium also contains a green resinous matter, which is soluble in ether. It is an irritant poison. As a medicine it is somewhat uncertain, its action being that of a drastic hydragogue purgative.

One fifth of a grain of elaterium given to a rabbit in two doses at an interval of twenty-four hours killed it in seventeen hours after the last dose.

FIG. 28.



One grain has been known to act violently in the human subject, and Christison records a case where bad symptoms, lasting for twelve hours, were caused by merely carrying the plant in a hat on the head.

The symptoms produced by it are vomiting, violent purging, and great depression. The medicinal dose is $\frac{1}{8}$th to $\frac{1}{4}$ or $\frac{1}{3}$rd of a grain, if the elaterine be good.

Elaterine (C_{20} H_{28} O_5.)

Elaterine is prepared by acting on elaterium with spirit, filtering off the fibrous and starchy matters, when the elaterine and the resin remain in solution. From this the resin is got rid of by pouring the concentrated alcoholic filtrate into a warm solution of potash, by which means the resin remains dissolved, whilst the elaterine is deposited in the form of crystals.

It is very bitter, freely soluble in alcohol, and but very slightly soluble either in water or ether. It is doubtful if it be a glucoside.

Nitric acid has no action upon it. Sulphuric acid turns it of a reddish brown colour.

14. DIOSCOREACEÆ.

Tamus Communis.

(Black Bryony.)

The black bryony is common in hedges. It has no tendrils. The leaves are smooth and heart-shaped, the berries ovoid and red, and the root black.

The berries are an irritant poison, and have produced bad symptoms.

15. EUPHORBIACEÆ.

Croton Tiglium.

(Purging Nuts—Croton.)

The seeds of the croton are similar in appearance to castor oil seeds, but smaller, not so bright, and marked by longitudinal lines. They are without smell, but have an acrid taste.

They contain 50 to 60 per cent. of an oil (croton oil) which is of a light yellow colour, soluble in ether, and turns dark brown when treated with nitric acid.

Both the seeds and the oil are active irritant poisons, their activity being due to a volatile fatty acid (crotonic acid) which is destroyed by saponification with potash. (Pelletier and Caventou.)

The symptoms usually occur within a short time after the poison has been swallowed. Intense pain, and a cholera-like condition, such as cramps, a cold blue skin, imperceptible pulse, and rice-water stools, with purging and collapse, are the ordinary symptoms.

Death has occurred in as soon as three hours, whilst it has been delayed for three days. Life is rarely, however, prolonged beyond ten hours.

Three minims of the oil has caused death in a child thirteen months old, and half a dram in an adult. Recovery is recorded after doses of 45 and 55 drops, and even after as much as half an ounce.

The experiments that have been made with croton oil on animals are not numerous. Forty seeds killed a horse in seven hours, and a dog died after thirty minims of the oil (Landsberg). Christison found that four minims would produce severe symptoms in a dog, whilst fifteen to twenty minims would ordinarily prove fatal from the exhaustion produced by excessive purging.

Cases of Poisoning with Croton Oil.

<table>
<tr><td colspan="3">1.
"Ann. d'Hyg.," 1871, vol. i., p. 409 (M. Chevallier). Male adult. ℥ss in mistake for cod liver oil.</td></tr>
<tr><td><i>Symptoms.</i>—Burning sensation; vomiting, purging, with symptoms of collapse. Recovery in 14 days.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">2.
"Ann. d'Hyg.," 1871, vol. i., p. 409 (Devergie). Male: æt. 25. ʒiss of the oil.</td></tr>
<tr><td><i>Symptoms.</i>—Purging, collapse, death.</td><td><i>Result.</i>—Death in 4 hours.</td><td></td></tr>
<tr><td colspan="3">3.
"Lancet," Aug. 21, 1869, p. 284 (Dr. Manvezin). Female: æt. 6. 45 drops of the oil.</td></tr>
<tr><td><i>Symptoms.</i>—Burning pain; vomiting; went to sleep for four hours, and afterwards had no further bad symptoms.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">4.
"Medical Times," Nov. 30, 1839, p. 75. Male: æt. 25. Large quantity. "Journal de Chim. Méd.," 1839, p. 509.</td></tr>
<tr><td><i>Symptoms.</i>—In ¾ of an hour was found with scarcely a perceptible pulse; difficult respiration; lips, eyes, and extremities blue; pupils normal but insensible; abdomen very tender, and attempts to vomit frequent. After a short time he became as it were intoxicated. Diarrhœa set in in 1½ hours. He gradually lost sensibility, and died in about 4 hours.</td><td><i>Result.</i>—Death in 4 hours.</td><td><i>Post-mortem.</i>—Mucous membrane of stomach slightly softened. A few spots of ulceration found in the intestines; otherwise normal.</td></tr>
<tr><td colspan="3">5.
"Lancet," April 16, 1870, p. 553 (Dr. Augé). Female: æt. 6. 55 drops of oil.</td></tr>
<tr><td><i>Symptoms.</i>—Diarrhœa and fever for 3 or 4 days, but recovery took place without any bad symptoms.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">6.
"British Medical Journal," Feb. 14, 1874, p. 211. Female: æt. 53. Oil taken by mistake for cough mixture.</td></tr>
<tr><td></td><td><i>Result.</i>—Death.</td><td></td></tr>
<tr><td colspan="3">7.
"Medical Times and Gazette," Aug. 1866, p. 142 (Dr. Greenhow). 30 m. of croton oil.</td></tr>
<tr><td><i>Symptoms.</i>—In 2 hours had very much the appearance of a patient suffering from cholera; purging (rice water stools) and cramp; surface cold, and skin blue; pulse almost imperceptible; gasping respiration; intellect clear.</td><td><i>Result.</i>—Death in 10 hours.</td><td></td></tr>
<tr><td colspan="3">8.
"Medical Gazette," vol. 43, p. 41. Female.</td></tr>
<tr><td><i>Symptoms.</i> — Hot burning sensations came on directly. Death in convulsions.</td><td><i>Result.</i>—Death in 3 days.</td><td></td></tr>
</table>

9.

"Edinburgh Medical Journal," Aug. 1861 (Dr. Brydon). Female: æt. 19. Half a teaspoonful with olive oil.

Symptoms.—Intense pain in throat and gullet in ½ an hour. Violent vomiting, and then pain in the stomach; no violent purging. Recovery in a day or two.	*Result.*—Recovery.	

10.

"Medical Times and Gazette," 1870, vol. ii., p. 466. æt. 13 months. 3m. with soap liniment.

	Result.—Death in 5 hours.	

The following Cases of Poisoning by the Oil and Seeds are also recorded:—

"Medical Times and Gazette," Nov. 20, 1858, p. 528 (Reg. *v.* Hippenstall).

"Lancet," Aug. 4, 1866, p. 139.

"Medical Times and Gazette," March 7, 1874, p. 272 (24 people made very ill from taking croton oil seeds).

"Pharmaceutical Journal," Feb. 1863, p. 379.

Euphorbia Officinarium and other species.

(Spurgeworts.)

Euphorbium consists of the dried milky juice which exudes from the stems of the various forms of spurgeworts. It contains about 44 per cent. of a resin which constitutes the active principle. The juice, which is intensely acrid, is used by farriers as a vesicant. The seeds of some species, yield as much as 40 per cent. of an oil which is very similar both in action and appearance to croton oil.

Euphorbium is a narcotico-acrid poison, vomiting and purging with coma and convulsions being the symptoms recorded as produced by it. Its application to the skin produces a nettle-rash eruption. A prosecution is recorded against a man for putting some of the powder in his maidservant's bed, whereby a violent and painful eruption of the skin was produced. The men engaged in grinding the powder are said to suffer from giddiness and stupor.

Half an ounce secured in the stomach of a dog proved fatal in twenty-six and a half hours, whilst two drams applied to a wound destroyed life in twenty-seven hours.

Cases of Poisoning with various species of Euphorbia.

(I.) EUPHORBIA OFFICINARUM.

1.

"Journal of Science," vol. iii., p. 51, "Christison" (Mr. Furnival). Male. A teaspoonful.

Symptoms.—Pain and heat in throat and stomach; vomiting set in rapidly, pulse irregular. Death.	*Result.*—Death in 3 days.	*Post-mortem.*—Gangrenous spots found in stomach. Spleen very rotten.

2.

Beck's "Medical Jurisprudence" (Dr. Willis). Female. ℥ij of the tincture, mixed with camphor.

Symptoms.—Immediate pain, and feeling of suffocation; (relieved by emetics.)	*Result.*—Recovery.	

(II.) E. PEPLUS.

3.

"Medico-Chirurgical Review," vol. vii., p. 275. Male: æt. 6.

Symptoms. — Vomiting, purging, spasms, insensibility. Death.	*Result.*—Death.	*Post-mortem.* — Fauces and pharynx much inflamed; stomach and intestines inflamed; large intestines healthy; bladder contracted.

(III.) E. LATHYRIS.

4.

"Christison," p. 589 (Dr. Hood). 2 seeds.

Symptoms. — Vomiting; afterwards drowsiness, passing into intense sleep; convulsions; stertorous breathing. Recovery.	*Result.*—Recovery.	

Hippomane Mancinella (or Manzanilla.)

(Manchineel.)

The milky juice, the apples, and the wood of this tree are poisonous. Two drams applied to a wound killed a dog in twenty-eight hours, with violent diffuse cellular inflammation, whilst one dram proved fatal in nine hours when administered internally.

By merely rubbing the green wood on the skin, violent inflammation is produced. The carpenters who work with manchineel have to protect themselves from the dust by gauze masks. It is even asserted by good authorities (although doubted by Ricord) that the sleeping under the tree and receiving the droppings of moisture on the sound skin will produce dangerous symptoms. Merely collecting the juice has produced bad effects ("Medical Times and Gazette," December 23, 1871, p. 770).

Jatropha Curcas. (*West Indies.*)

(Physic Nut—Indian Nut—Juva Tree.)

The seeds of this plant contain an acrid oil, which, in appearance, is not unlike croton oil. Twelve to fifteen drops will act powerfully, whilst the cake from which the oil is expressed, produces violent symptoms in doses of even a few grains. Four seeds act as a powerful cathartic. It is an irritant poison.

The *Jatropha Urens,* from the stories that are recorded, seems to be extraordinarily powerful in its action. Even the touching it may induce dangerous symptoms. At Kew, one of the gardeners is reported merely to have allowed his wrist to come in contact with the plant, when in a few minutes such severe symptoms of collapse set in, that the man was supposed to be dead. ("Pharmaceutical Journal," April 17, 1872, p. 863.) He afterwards rallied.

The juice of the root of the *Jatropha Manihot* (Cassava plant), from which tapioca is obtained, has been known to prove fatal. It is a narcotico-acrid poison.

The *Jatropha multifida* is also poisonous.

Cases of Poisoning by species of Jatropha.

<table>
<tr><th colspan="3">(I.) JATROPHA CURCAS (PHYSIC PLANT).</th></tr>
<tr><td colspan="3">1.
"Medical Times and Gazette," June 25, 1864, p. 703; Aug. 7, 1858, p. 143. 139 children eat the nuts at Dublin.</td></tr>
<tr><td colspan="3">2.
"Annales d'Hygiène," 1871, vol. i., p. 408 (M. Chevallier). Thirty-three persons poisoned by eating the seeds. Thirteen recovered.</td></tr>
<tr><td>*Symptoms.*—Nausea; vomiting and general depression.</td><td></td><td></td></tr>
<tr><th colspan="3">(II.) JATROPHA MANIHOT.</th></tr>
<tr><td colspan="3">3.
Beck's "Medical Jurisprudence" (Dr. Clark). Male: adult. ½ pint of juice.</td></tr>
<tr><td></td><td>*Result.*—Death in 1 hour.</td><td></td></tr>
<tr><td colspan="3">4.
Beck's "Medical Jurisprudence." 36 drops of the juice.</td></tr>
<tr><td>*Symptoms.*—Convulsions and death.</td><td>*Result.*—Death in 6 minutes.</td><td>*Post-mortem.*—Nothing abnormal, except that the stomach was shrunk to about half its ordinary size.</td></tr>
</table>

Ricinus communis (Fig. 29).

(Castor Oil Plant.)

Castor oil is well known as a safe and mild purgative, but the seeds from which it is extracted are very poisonous.

The castor oil seed is about the size of a small bean, oval, smooth, shining, and marked with dark spots. The poisonous principle is certainly not in the oil, but opinions somewhat differ as to what it is, or where it really exists. No doubt the seed is rendered more poisonous by the heat requisite for extracting the oil, whilst its intensity of action is much influenced by climate. The seeds, therefore, are poisonous, both to man and animals, even after the extraction of the oil. It is a curious fact that the outer covering of the seed, from its corky indigestible nature, may prevent the seed acting injuriously if it be swallowed without being masticated or being otherwise bruised.

Symptoms, Dose, &c.

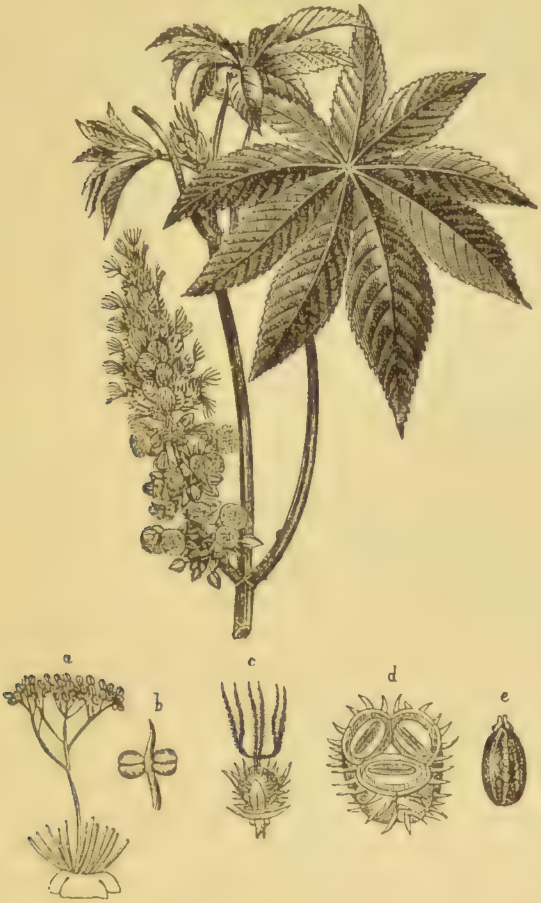
The symptoms may be delayed for some hours. They are those of an irritant poison. Bloody stools have been noticed, with violent cramps and suppression of urine. Death is usually somewhat tardy (two to five days).

Three grains of the fresh seed, and in a second case one seed, have produced bad symptoms; whilst there are cases on record of death in one case from three seeds, and in another from twenty. It is said that the Hungarians eat these seeds freely, but this, we think, must be a mistake.

The post-mortem appearances and treatment are those of an irritant poison.

In examining the contents of the stomach particular search must be made for the variegated outer coats of the seed (pale grey with yellowish brown spots) which are not likely to be dissolved by the digestive fluids. Some castor oil may also probably be extracted from the contents, which, unlike most fixed oils, is soluble in alcohol.

FIG. 29.



Cases of Poisoning with Castor Oil Seeds.

1. Taylor's "Medical Jurisprudence," p. 328, vol. i. Female: æt. 18. 20 castor oil seeds.		
Symptoms.—In 5 hours faintness and sickness, with vomiting and purging, set in. On the morning afterwards, she appeared as if she was suffering from malignant cholera, the skin being cold and dark coloured; breath cold; pulse small and wiry; thirst, restlessness; abdominal pain; semi-consciousness; everything taken was vomited; stools consisted merely of blood and serous fluid.	*Result.*—Death in 5 days.	*Post-mortem.*—A large part of the mucous membrane of the stomach found softened and abraded.

2. Taylor's "Medical Jurisprudence," p. 328, vol. i. (1.) Female: æt. 4 or 5. (2.) Female: æt. 2		
Symptoms.—Both taken ill very soon.	*Result.*—Recovery.	
3. "Medical Times and Gazette," May 25, 1861, p. 555. Male: æt. 32. 3 seeds, from which the husks had been removed.		
Symptoms.—Colic and vomiting came on in 9 hours. In 24 hours the symptoms were very severe.	*Result.*—Death in 46 hours.	*Post-mortem.*—Stomach and intestines congested throughout; no ulceration was noticed.
4. "Annales d'Hygiene," 1871, vol. i., p. 400 (M. Chevallier). Female. A quantity of bruised seeds.		
Symptoms. — Vomiting and bloody purging came on quickly. Death.	*Result.*—Death on fifth day.	*Post-mortem.*—The mucous membrane of the stomach and bowels was dark coloured and ecchymosed, and there were several patches of extravasations of blood.
5. "Jahresbericht," 1872, p. 538. Male: adult. 17 seeds.		
Symptoms. — In 3 hours purging, vomiting, and cramp; vomiting continued for 21 hours, and suppression of urine for 48. Recovery.	*Result.*—Recovery.	
6. "Medical Times and Gazette," 1870, vol. i., p. 581 (Mr. Little). Æt. 8 and 3. Several seeds (?) were masticated by the children.		
Symptoms.—Great collapse with vomiting and purging; surface of body pale and perspiring; stools frequent and watery; great pain and thirst.	*Result.*—Recovery.	
7. "Lancet," March 31, 1866, p. 357. Male: adult. A few of the seeds.		
Symptoms.—Vomiting; purging: pain in stomach and gullet; prostration extreme.	*Result.*—Recovery.	
8. Christison, p. 690 (from Orfila) (Bergin). Male: adult. Masticated 1 seed.		
Symptoms.—Vomiting; purging.	*Result.*—Recovery.	
9. Christison, p. 590 (from Orfila) (Lanzoni). Female: adult. 3 grains of the fresh seed.		
Symptoms.—Vomiting; hiccup; pain; faintness; twisting of bowels; syncope.	*Result.*—Recovery.	

16. FUNGALES.

Secale cornutum.

Ergot of Rye—Spurred Rye—Seigle Ergoté (Fr.)—Mutterkorn or Roggenmutter (German).

Wheat, barley, oats and rye, but especially the latter, are liable to be attacked by the ergot disease, particularly when they are grown on ill-drained soils. Damp seasons are also specially favourable to the development of the ergot. The spur varies in size from a quarter to one inch in length, and from one-sixth to one-third of an inch in thickness. Externally it appears of a deep purple colour, having upon it two or three streaks of dotted grey, and a bloom consisting of the sporidia of the fungus. Internally it is white or pink. The sound rye is specifically heavier than the diseased rye. The ergot is tough but brittle, very hygroscopic, having an acrid taste and a disagreeable odour. It yields its active principle to both alcohol and water.

By acting upon it with a solution of potash, the ergot odour is freely disengaged, and a lake-red pulp remains behind. It loses its activity by keeping, especially when it has become moist and mouldy.

Ergot contains about 35 per cent. of a fixed non-active oil, and about 15 per cent. of an active principle called *ergotine*. It is said to contain hydrocyanic acid, but of this there is great doubt.

Experiments on Animals.

The experiments on animals require notice. It acts as a poison to all animals, unless it produces early vomiting, which is found to be usually the case when administered to cats and dogs. The symptoms produced by it are at first giddiness, dilated pupils, and palsy ; and later on diarrhœa, suppurating tumours, gangrene, with even sometimes dropping off of the toes (Dr. Robert). Nine grains of the active principle killed a fowl in three days, death occurring in a convulsive fit (Wiggers.) Six grains proves fatal to sparrows in six or seven hours (Taddei). A strong infusion of from ʒijss to ʒvj of ergot injected into the jugular veins of dogs, destroyed life in periods varying from a few minutes to two hours, paralysis, spasms, coma, and a depressed action of the heart being ordinary symptoms. Suppuration, and an unhealthy exhausting discharge were produced whenever ergot was introduced into the cellular tissue. Given by the mouth three ounces proved fatal to a dog, the symptoms being those of an irritant poison accompanied with spasms, loss of sensibility, great muscular weakness, and a repulsive fetor of the excretions and secretions. (Dr. Wright in "Edinburgh Medical Journal.") Rabbits are far less influenced by ergot than dogs, (1) because they are accustomed to a vegetable diet, and (2) because idiosyncrasy greatly modifies the action of narcotics on herbivorous animals.

Symptoms.

The cases of poisoning by ergot, have chiefly arisen from its accidental admixture with flour. The bread is wanting in firmness, and very soon becomes moist. Two distinctly different poisonous disorders have been produced by it, and may present themselves either singly or combined. (1) *Nervous or convulsive ergotism.* This occurred in Germany in 1770, and in Schleiben in 1831 and 1832. Giddiness, cramps, and convulsions were the prominent symptoms. The cases proved fatal within twenty-four hours, but seemed amenable to treatment if taken in time. (2) *Gangrenous ergotism* (creeping sickness.) This occurred in Switzerland in 1709 and in 1716, and several times since in Germany. It begins with a peculiar creeping sensation, the limbs becoming insensible, and at last shrivelling up and dropping off at the joints

("Lancet," June 21, 1845). As a rule there are no premonitory symptoms. Ergot is much used in obstetric practice, and to arrest hæmorrhages from various organs, and is often administered for the purpose of procuring abortion from the remarkable power it possesses of promoting the contractions of the muscular coat of the gravid uterus. In the human subject the general symptoms of a poisonous dose are nausea, vomiting, delirium, and stupor, the pulse being diminished both in frequency and force.

The amount of urine is increased under its influence, and this fact is important, inasmuch as a loaded bladder may prove a serious hindrance to parturition. After death from ergot the bladder will probably be found very full.

Poisonous Fungi.

There are some varieties of fungi that, all the world over, are eaten with impunity, and probably the number perfectly harmless is larger than is usually supposed. Other varieties, however, are doubtful. One person will eat them without injury, whilst a mere taste will produce in another violent symptoms of poisoning. And lastly, there are other varieties which, whether eaten by man or animals, are uniformly productive of alarming and dangerous effects. It is even asserted that if the edible varieties be eaten constantly and for a long period, bad constitutional results, such as external suppurations and gangrene, may be produced. This assertion, however, must be received with some caution, inasmuch as it is put forward almost entirely on the evidence afforded by a single case (Rust's Journal).

1. *Is it possible to know, by any external signs, whether a fungus may be safely eaten or no?*

We are afraid not. The silver spoon becoming discoloured when boiled with a poisonous mushroom is only "an old woman's tale." But as a general principle, it may be stated that all fungi growing in marshy situations, having a warty cap, and smelling offensively, with a green or scarlet hue (like the fly-mushroom, which, in parts, is of a rich orange red colour) or that turn blue soon after being cut, or that are bitter to the taste and burning to the throat, should be avoided. The peculiar fungus to which the vine disease is due, is said to have produced fatal symptoms even by inoculation. ("British Medical Journal," November 4, 1865, p. 467.)

We may quote here the following tabulation, by Professor Bentley, of the general characters of edible and poisonous mushrooms :—

EDIBLE.	POISONOUS.
1. Grow solitary in dry, airy places.	1. Grow in clusters, in woods, and dark, damp places.
2. Generally white, or brownish.	2. Usually of a bright colour.
3. Have a compact brittle flesh.	3. Have a tough, soft, watery, flesh.
4. Do not change colour when cut and exposed to the air.	4. Change to a brown, green, or blue tint, when cut and exposed to the air.
5. Juice watery.	5. Juice often milky.
6. Odour agreeable.	6. Odour powerful and disagreeable.
7. Taste neither bitter, astringent, acrid, or salt.	7. Taste either bitter, astringent, acrid, or salt.

It is right, however, we should say that this table is apparently drawn up with the view of differentiating the common mushroom alone, from the other species that may possibly be mistaken for it. There are, however, species of fungi coming under almost all Bentley's dangerous category, which are reported to be excellent, whilst conversely there are some exceedingly poisonous without showing any of the dangerous signs described by him. (See Worthington Smith, Cooke, &c.)

2. *The commencement of the symptoms.*

There is in this matter an infinite variety, due, no doubt, to the different digestibility and states of preservation of the various forms of fungi. The same fungus will act differently on different people.

Cases are on record where the symptoms have commenced in ten minutes, thirty minutes, one and a half hour, two hours, two and a half hours; and in six, ten, twelve, twenty-four, thirty, and thirty-six hours. No rule, therefore, can be laid down.

3. *Symptoms.*

Fungi often act as *narcotics;* intense coma being the prominent symptom. At other times they act as *irritants;* with pain, purging, and vomiting; whilst, again, they may act *both as narcotics and irritants.* And this difference is not to be accounted for by the varying action of different species, for the same dish may produce the symptoms of an irritant in the one part of a family, and of a narcotic in the other. Giddiness, headache, dimness of sight, illusions, convulsions, and delirium are common symptoms.

4. *The circumstances that modify the action of fungi.*

These are not well understood. Some of the poisonous fungi at times do no harm—some edible ones, at other times, prove poisonous—some are said to be poisonous when fresh, but harmless when dried.

(*a*) *Cooking.* The active principle of a poisonous mushroom is believed to be volatile, and dissipated by the application of a moderate heat. It may in a great measure be got rid of either by boiling in water, or by soaking the mushrooms, cut into slices, in brine or vinegar ("British Medical Journal," Nov. 30, 1861, p. 585).

(*β*) *Idiosyncracy.* With some people all forms of fungi act injuriously; some being even affected by a little ketchup. There is, however, nothing strange in this circumstance, for to our certain knowledge, this favourite sauce often contains the juice of, at any rate, more than one form of fungus.

(*γ*) *Climate.* Some species are commonly eaten in Prussia and Russia, which are never eaten in France, whilst there are many that are eaten in France which we regard as poisonous in England.

(*δ*) *Weather.* Foderé states that the common morelle becomes injurious after a long rain. (?)

(*ε*) *Season.* It is asserted that the eatable mushroom becomes unsafe when the season is far advanced. (?)

5. *The active principles upon which the injurious action of fungi depend.*
This has been investigated by various experimenters.

Braconnot states that fungi contain a variety of principles, differing in different species, but consisting generally of an acrid resin, a saccharine body, and a spongy principle that he calls fungin, to which, however, he does not attribute their poisonous properties.

Letellier believes there are two active principles in fungi :

(*a*) *An acrid volatile principle*, to which he attributes their *irritant* properties, and which, being volatile, disappears when the fungus is dried or boiled in water.

(*β*) *An alkaloid* (amanitine), to which he attributes the *narcotic* symptoms. It is a more fixed body than the former, and forms salts with acids. Secard also believes in the existence of this alkaloid.

The *Agaricus muscarius* is said to contain a peculiar alkaloid (2 grs. to 2 lbs. of the agaric) called *muscarin* (MM. Schmeideberg and Koppe.) Its action is said closely to resemble calabar bean. It produces an extraordinary contraction of the pupil, and paralysis. (*Vide*, "Lancet," Nov. 20, 1869, p. 712.)

6. *Results.*

Many cases recover, especially if there has been early vomiting. In one case a man is reported to have suffered more or less for a year. Death takes place, however, usually within twenty-four hours, although it may be delayed for two or three days. In one recorded case the patient for a time got fairly well, and then had a relapse and died. Death is often ushered in by a convulsive fit.

7. *Treatment.*

Emetics of sulphate of zinc, the use of the stomach pump, and castor oil are indicated. There is no chemical antidote to the fungus poison, and so the treatment must consist in getting it out of the system as speedily as possible. It may be as well to note again how difficult and tedious the digestibility of fungi usually appears to be. After the fungus has been got out of the stomach, coma or inflammation, if they set in, must be treated on general principles.

8. *Post-mortem appearances.*

The stomach and intestines are often found intensely inflamed, and even gangrenous. The vessels of the brain are usually deeply congested and the liver enlarged.

Examination in a Case of Mushroom Poisoning.

The authors are indebted to Dr. Paxton, of Chichester, for the following hints :—

If possible endeavour to discover portions of the mushroom itself in the contents of the stomach. If such pieces are found, the gills should be scraped, and the scrapings examined with the microscope ($\frac{1}{4}$ in.) for spores. If no pieces can be obtained, then search should be made for the spores in the deposit as well as in the fluid contents, taking drops for this purpose from the surface, from the lower layer, and from the bulk of the liquid. The following facts should be noted, and are worth recording :—

(1) The spores are small bodies (generally about 0·0003 in. diameter), having unusually sharp outlines, and very much more defined than is usual with animal structures.

(2) The spores are not materially affected by frying, or even by boiling in glycerine.

(3) The spores of the same species of fungi are very definite in shape and appearance.

(4) The spores of the common mushroom are oval, and dark slate coloured, and very like those of some of the poisonous species (hypholoma).

(5) The discovery of *pink irregular spores* (entoloma), or of *rusty brown irregular spores* (hebeloma), or of *round white prickly spores* (russula, lactarii), would be strong evidence that a poisonous mushroom had been eaten.

(6) The discovery of *plain round spores* would prove nothing beyond the fact that a mushroom had been eaten, such spores being found both in edible and poisonous mushrooms.

We must refer to one other matter deserving attention, that is, the possibility of a mushroom being the vehicle for the administration of a poison by a criminal in order to disarm suspicion ; and, therefore, where there is any reason to suspect unfair dealing, the symptoms must be carefully studied, and a complete analysis made to see whether any poison other than the fungus is present.

Cases of Poisoning by various forms of Fungi.

<table>
<tr><td colspan="3">1.
"London Medical and Physiological Journal," vol. xxxvi., p. 451. Male: adult. Eat stewed *Agaricus campanulatus.*</td></tr>
<tr><td>*Symptoms.*—In 10 minutes he was attacked with giddiness, dimness of vision, debility, tremblings, loss of memory. Extreme drowsiness came on. (An emetic was given); the next day he was tolerably well.</td><td>*Result.*—Recovery.</td><td></td></tr>
<tr><td colspan="3">2.
"Annali Universali di Medicina," 1842, vol. i., p. 549. Male : æt. 14. *Agaricus Pantoerinus.*</td></tr>
<tr><td>*Symptoms.*—In two hours was seized with delirium and convulsions; and afterwards intense coma. (Soon recovered under the use of emetics.)</td><td>*Result.*—Recovery.</td><td></td></tr>
<tr><td colspan="3">3.
Corvisart, "Journal de Médecine," vol. xxxi., p. 323. Four soldiers. Eat *Amanita Muscaria.*</td></tr>
<tr><td>*Symptoms.*—All were taken ill within six hours with griping pains, thirst, and a sense of suffocation. The abdomen became swollen, and a profuse fetid diarrhœa came on. Delirium and death occurred in all four. Several others were affected, in some cases the coma lasting for 24 hours.</td><td>*Result.*—Death.</td><td></td></tr>
<tr><td colspan="3">4.
Orfila, "Toxicologie," vol. ii., p. 433. Man, wife, servant, and 3 children. Eat *Amanita citrina.*</td></tr>
<tr><td>*Symptoms.*—The wife, the servant, and one of the children, had vomiting followed by deep coma, from which they afterwards recovered. The husband had violent diarrhœa and also recovered. The other two children had profound coma and died.</td><td>*Result.*—Death and recovery.</td><td></td></tr>
</table>

5.

Christison, p. 925. Six persons: 2 adults, 4 children. Eat *Hypophyllum sanguineum* (puddock stool).

Symptoms.—Symptoms set in after periods varying from 12 to 30 hours. 1. Child (æt. 7) had acute abdominal pain and swelling; succeeded by coma. Convulsions and death occurred in a tetanic paroxysm. 2. Child (æt. 10). Death in still more violent convulsions. 3. Mother had vomiting and bloody stools. Death in 36 hours, comatose. 4. Child died on the third day, after a relapse, with convulsions. 5. Child had colic and delirium, but recovered. 6. Father had an attack of dysentery, was speechless for three days, and recovered, but was not well afterwards for more than a year.	*Result.*—Death and recovery.	

6.

"Edinburgh Medical and Surgical Journal," vol. xlix., p. 192 (Dr. Peddie). (1) Male: adult. (2, Male: æt. 13. Eat the *Agaricus procerus.*

Symptoms.—In 30 minutes both appeared giddy as if intoxicated, and in 1 hour there was perfect insensibility. Sensibility returned after the use of stimulants and the stomach pump. Convulsive spasms came on, and furious delirium. The bowels were not affected, nor was there any pain. During sleep the pupils were contracted, but dilated on waking.	*Result.*—Recovery.	

7.

"Medical Times and Gazette," Nov. 21, 1863, p. 536 (Mr. Taylor, Emsworth). Male: æt. 13.

Symptoms.—In 10 or 11 hours after eating two fungi the boy felt ill, and vomited; this was followed by purging, and pains in the abdomen; great tenderness, constant vomiting, thirst, and great depression. Death took place in 44 hours after eating the fungi, and 34 from the beginning of symptoms. Others eat the same fungi and did not suffer.	*Result.*—Death.	*Post-mortem.*—Left ventricle contracted and empty; lungs healthy; stomach and small intestines much injected.

8.

Huseman, "Jahresbericht," 1872, p. 534. Male: æt. 43. Female: æt. 5. Eat the *Amanita panthernia.*

Symptoms.—Symptoms of faintness, delirium, and nausea appeared in 2½ hours; in 11 hours stupor and abdominal tenderness. In the child the pupils were contracted.	*Result.*—Recovery.	

9.

"Lancet," Oct. 4, 1873, p. 501. Female. A female died from poisonous mushrooms, and the man who gave them was tried for murder at the Central Criminal Court.

	Result.—Death.	

10.

"Lancet," Oct. 25, 1851, p. 384. Two adults. Eat mushrooms for dinner.

Symptoms.—Violent pains in a few hours. Died in horrible agony the following morning.	*Result.*—Death.	

11.

"Lancet," Sep. 18, 1852, p. 273. Two persons eat some mushrooms (?) for supper.

Symptoms.—The next morning they were seized with violent symptoms, and died in great agony.	*Result.*—Death.	

<table>
<tr><td colspan="3">12.
"British Medical Journal," June 27, 1863, p. 672 (Dr. Mitchell). Two adults.</td></tr>
<tr><td><i>Symptoms.</i>—Great pain and distension in stomach; dimness of sight; no vomiting or purging. After the action of a good purge both recovered, but for a time suffered from nervous twitchings.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">13.
"British Medical Journal," Oct. 24, 1863, p. 461 (Mr. Sadler). Spores of <i>Lycoperdon giganteum</i> (puff-ball).</td></tr>
<tr><td><i>Symptoms.</i>—Violent symptoms set in in half-an-hour.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">14.
"Lancet," March 29, 1862, p. 325 (Dr. O'Connor). Male: æt. 7. Toadstools.</td></tr>
<tr><td><i>Symptoms.</i>—Collapse; insensibility; vomiting, dilated pupils; intense prostration.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
</table>

Other Cases of Poisoning by different forms of Fungi are recorded as follows:—

"Guy's Hospital Reports," 1872, p. 228.
"Medical Gazette," vol. xxv., p. 110.
"Medical Times and Gazette," Oct. 26, 1861, p. 443. (Recovery.)
,, Oct. 18, 1851, p. 423. (Mushrooms.)
"British Medical Journal," Jan. 19, 1861, p. 78. (Deaths.)
,, Sep. 14, 1861, p. 288.
,, Nov. 30, 1861, p. 585. (9 cases.)
,, Aug. 31, 1861, p. 239. (3 men died within 24 hours from eating mushrooms. Convulsions.)
,, Oct. 10, 24, 31, Nov. 21, Dec. 5, 1874, pp. 464, 524, 555, 645, 706.

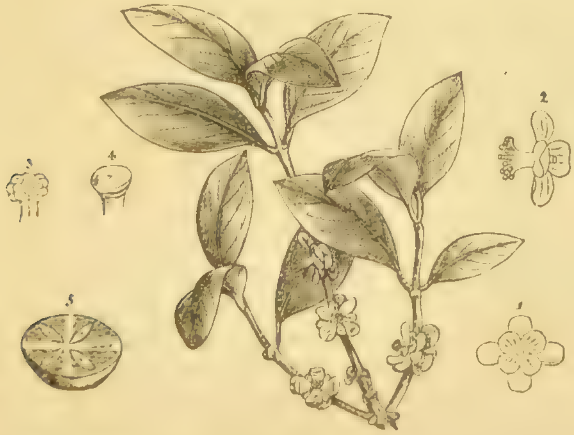
17. GUTTIFERÆ.

Hebradendron Gambogioides. (Fig. 30.)

(Garcinia Morella.)

The gum resin of this plant, called Gamboge, is a bright yellow, hard brittle substance. It has no smell, and when first put into the mouth has but little taste.

FIG. 30.



The gum resin (gamboge) contains 75 to 80 per cent. of a resin called gambogic acid ($C_{20} H_{23} O_4$), and from 20 to 25 per cent. of gum.

The gum is soluble in water, the resin remaining suspended. The resin is soluble in alcohol, but is re-precipitated on adding water.

Gamboge is an irritant poison. It forms an important ingredient of most quack pills. One dram has proved fatal to an adult, but large doses seem to have been administered in some cases without any bad effects resulting.

Orfila, Schubarth, and Wigmer have experimented with it on animals. Two drams killed a sheep, and a dram and a half a dog. If it be not secured in the stomach, however, large doses can be given, without injurious results, because of the free vomiting induced. One ounce had no effect on a horse, but 18 grains was found to kill a rabbit in twenty-four hours. Great inflammatory action was produced when the poison was applied to a wound

18. GRAMINACEÆ.

Lolium Temulentum.

(Bearded Darnel.)

The cases of poisoning recorded with darnel have been invariably due to the accidental admixture of the seeds with wheat. It is stated that chickens will eat darnel seeds without any injurious results being produced. Bley of Bemburg has obtained from them a bitter extractive matter which proved fatal to a pigeon.

The symptoms usually manifested are headache, a staggering intoxication, general tremors, paralysis, great sleepiness, impaired vision and vomiting.

Sometimes, however, its action seems to be entirely that of an irritant poison, without any admixture of narcotic symptoms.

As a rule patients recover.

Cases of Poisoning by the Lolium Temulentum (Darnel).

<table>
<tr><td colspan="3">1.
"Edinburgh Monthly Journal," Aug. 1850, p. 180, and Taylor's "Medical Jurisprudence,' vol. ii., p. 397. (Dr. Kingsley.) Thirty persons eat bread containing darnel seeds mixe accidentally with the flour of which it was made.</td></tr>
<tr><td><i>Symptoms.</i> — Giddiness; symptoms similar to those of delirium tremens; impaired vision; great prostration; in some cases vomiting.</td><td><i>Result.</i>—All recovered in 24 hours.</td><td></td></tr>
<tr><td colspan="3">2.
Christison, p. 945. Eighty persons at Sheffield attacked after eating oatmeal, believed to contain darnel.</td></tr>
<tr><td><i>Symptoms.</i>—Great agitation of limbs; confusion of sight; dilated pupils; convulsions in two cases.</td><td><i>Result.</i>—All recovered in 12 hours.</td><td></td></tr>
<tr><td colspan="3">3.
Christison, p. 945. A farmer, his wife, and a servant, eat bread made of flour containing 1 part wheat and 5 parts darnel seed.</td></tr>
<tr><td><i>Symptoms.</i>—All were violently affected with vomiting and purging; both the farmer and the servant died as if from colic; the wife recovered.</td><td><i>Result.</i>-Two died. One recovered.</td><td></td></tr>
</table>

19. LAURACEÆ.

Camphora officinarum.

Camphor ($C_{10}H_{16}O$).

(Common or Laurel Camphor.)

(There is another variety called *Borneo camphor* ($C_{10}H_{18}O$) obtained from the *Dryobalanops aromatica.* It is heavier than water.)

Camphor floats in water (sp. gr. 0·98). It is a colourless, transparent, crystalline solid, and has a cool pungent taste. It readily and completely sublimes by heat.

It is slightly soluble in water (forty grains per gallon), its solubility being increased by the addition of tincture of myrrh. It is very soluble in alcohol, but the camphor is thrown down when water is added to the solution. It is also soluble in ether and chloroform, and in the fixed and volatile oils.

Camphor is a concrete volatile oil. Nitric acid changes it to camphoric acid.

Symptoms—Dose.

The ordinary effects of an overdose of camphor are giddiness with imperfect sight, cramps, numbness of the extremities, apparent intoxication, difficulty of breathing, thirst, and sometimes convulsions. Recovery is generally preceded by a long deep sleep, during which there is profuse perspiration, the patient waking up in a state of intense exhaustion.

If the poison has been given in solid pieces we may expect to meet with the general symptoms of an irritant poison. Usually the odour of camphor will be detected in the breath.

In nearly all cases recovery is recorded. Thirty grains has proved fatal in seven hours to a child one and a half years old. Severe effects have apparently resulted from small doses (Dr. Johnson), although it is recorded that doses of ninety grains, repeated four times daily, have been taken without bad results (Christison).

Post-mortem Appearances.

The membranes of the brain are usually found to be injected, and the stomach and bowels inflamed, with considerable congestion of the genito-urinary tract.

Experiments on Animals.

From the experiments of Orfila and Scudery we learn that when camphor was given to dogs *in solution*, tetanic convulsions, accompanied by a wild active delirium were produced. Camphor fumes were given off by the mouth. An intense coma generally succeeded, and after this, death was rapid. When the camphor was administered *in solid pieces*, no convulsions were produced, whilst death was slow, and resulted chiefly from inflammation of the stomach and alimentary canal. Twenty grains dissolved in olive oil and injected into the jugular vein, killed a dog in ten minutes (Orfila).

After death a smell of camphor was noticeable throughout the whole body. The genito-urinary tract was very congested. When solid camphor had been given, great inflammation was found in the stomach and intestines. Arterial blood was found in the left side of the heart, and camphor was detected in the blood itself (Lebükchner.)

Treatment.

The treatment must consist mainly in the administration of emetics (for to get rid of the poison is the first thing to be done), and after this a full dose of castor oil.

In conducting a medico-legal inquiry, carefully examine all parts for the peculiar camphor odour, and also search for undissolved portions of the poison, which are not unlikely to be present because of its imperfect solubility. The solid contents should then be acted upon with strong alcohol and filtered, when, on the addition of water to the alcoholic solution, the camphor will be precipitated, and may be recognised by its smell and general characters.

Cases of Poisoning with Camphor.

<table>
<tr><td colspan="3">1.
Christison, p. 909. Male: adult. ʒss used as an injection.</td></tr>
<tr><td><i>Symptoms.</i>—Uneasiness set in in a few minutes; considerable weakness and numbness remained for some time.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">2.
Christison, p. 910 (Dr Eickhorn). Male: adult. ʒij taken in small doses during 3 hours.</td></tr>
<tr><td><i>Symptoms.</i>—Heat; palpitation; pleasant intoxication; sleep and perspiration; no bad results followed except debility.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">3.
Christison, p. 910 (Wendt, of Breslau). Male: adult. 160 grs. in solution in alcohol.</td></tr>
<tr><td><i>Symptoms.</i>—No vomiting. The patient was a drunkard; great pain in the stomach; giddiness; some delirium; a difficulty of passing water remained for some days.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">4.
"Lancet," Sep. 24, 1842 (Mr. Hallett). Female: adult. 20 grains in spirit with tincture of myrrh.</td></tr>
<tr><td><i>Symptoms.</i>—Immediate intoxication; delirium; occasional loss of sight; pupils natural; numbness of extremities; no pain. She got much better under treatment, but had a relapse after 24 hours from which she recovered, with occasional attacks of dyspnœa.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">5.
"Lancet," Nov. 22, 1873, p. 740 (Dr. G. Johnson). Female: æt. 20. 25 drops of Epps' Concentrated Solution (=℥j of camphor to ʒss alcohol).</td></tr>
<tr><td><i>Symptoms.</i>—Violent convulsions; foaming at mouth; bloody vomiting and severe pain came on very soon; partial paralysis continued for several days, and nervous symptoms for 6 months.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
</table>

6.

"Lancet," Nov. 22, 1873, p. 740 (Dr. G. Johnson). Male: adult. 3m. of above solution taken every 5 minutes for 1 hour.

Symptoms.—Intense headache and extreme prostration preventing him doing his work for 2 months.	*Result.*—Recovery.	

7.

"Lancet," Nov. 22, 1873, p. 740 (Dr. G. Johnson). Female: æt. 19. A teaspoonful of above solution.

Symptoms.—Coma; lasting for several days.	*Result.*—Recovery.	

8.

"Berliner Klin. Wochenschrift," Sept. 1, 1873 (Dr. Klingelhöffer). Female: adult. 30 grains.

Symptoms.—Immediate giddiness; intense pain; tremors; camphorous odour of breath.	*Result.*—Recovery.	

9.

"British Medical Journal," Dec. 6, 1873, p. 67 (Dr. Allbutt). Male: æt. 28. About 20 drops of homœopathic solution.

Symptoms.—Great giddiness; headache; nausea; considerable lethargy; recovery.	*Result.*—Recovery.	

10.

"Bull. de Ther.," vol. lxxvi., p. 379. Child. 26 grains.

Symptoms. — Twitchings of countenance; efforts at vomiting; cold perspiration; convulsions; stupor and retention of urine (coffee administered).	*Result.*—Recovery in 6 hours.	

11.

"Medical Times and Gazette," June 25, 1859, p. 658 (Dr. Braithwaite). Male. Large dose (about 30 grs.) for gleet.

Symptoms.—Furious delirium in about 1 hour; pupils dilated; symptoms aggravated when a light was brought near the patient; in 20 minutes became very quiet but muttered incoherently. In four hours and a half afterwards he was well.	*Result.*—Recovery.	

12.

"Medical Times and Gazette," Dec. 18, 1858, p. 645. Male. Over 200 grains taken every morning fasting.

Symptoms.—No effect until the fourth day, when gastric pains set in. On the fifth day he doubled the dose, and took one at night as well as one in the morning. Intense pain in the head came on; appeared intoxicated; became insensible; after an emetic sensibility returned; he then slept for 24 hours and woke up well.	*Result.*—Recovery.	

13.

"British Medical Journal," Feb. 2, 1867. Male: æt. 20. Camphorated oil.

Symptoms.—Became insensible in 2½ hours; opisthotonos; (ipecacuanha and cold applications to the head were used).	*Result.*—Recovery.	

14. Guy's "Forensic Med.," p. 519. Male : adult. 20 grs. in spirit.		
Symptoms.—Immediate giddiness; fits of laughter; cramp; loss of voice; great debility.	*Result.*—Recovery.	
15. "British Medical Journal," March 14, 1863, p. 284. Æt. 15 months. A teaspoonful of camphorated oil.		
Symptoms.—Convulsions and vomiting.	*Result.*—Death in 13 hours.	
16. "Journal de Chimie Médicale," 1850, p. 507. 3 children. Æt. 3, 5, 1½. 30 grains to each child		
Symptoms.—Delirium; great thirst; vomiting, purging, and convulsions.	*Result.*—Two children recovered. The youngest died in 7 hours; comatose.	
17. "Medical Gazette," vol. ii., p. 772. Male. ʒij.		
Symptoms. — Exhilaration; profound sleep; profuse perspiration during sleep; and great exhaustion afterwards.	*Result.*—Recovery.	
18. Christison, p. 909. Male. ʒij.		
Symptoms.—Very languid and restless after 20 minutes; in 1 hour became confused and giddy; at last lost consciousness, and convulsions set in; (an emetic was administered, which brought away nearly all the camphor).	*Result.*—Recovery.	

See also other Cases of Poisoning by Camphor as follows:—

"Medical Times," July 11, 1846, p. 285. Male : æt. 20. ʒij of camphor.
"Medical Gazette," vol. xlviii., p. 552. ʒj used as an enema.

20. LEGUMINOSÆ.

Arachis Hypogœa.

(Ground Nut—Denna Nut—Munduli.)

This nut, which comes from the West Coast of Africa, is shaped like an hour-glass, reticulated externally, and contains two brown beans.

It is recorded ("Lancet," July 19, 1873) that they sometimes prove dangerous,—vomiting, diarrhœa, drowsiness, and dilated pupils being produced. The authors believe that these nuts are perfectly harmless.

Cytisus Laburnum.

(Laburnum.)

All parts of the plant—wood, bark, leaves, flowers, pods, and seeds—act as narcotico-acrid poisons. Its activity is due to the alkaloid "*cystisin*," which is said to be the active principle of the Australian or Persian insect-powder. It has no well-marked chemical properties.

The decoction of laburnum bark turns olive green when acted upon with a persalt of iron.

The symptoms produced by it usually set in rapidly. Purging, vomiting, extreme restlessness, afterwards drowsiness and insensibility, with convulsive twitchings, are commonly recorded. Death has occurred from the seeds in six days, and from the bark in 13 hours.

Christison found that twenty to seventy grains of the dried bark caused vomiting in a dog, and that an infusion of one dram, given to a rabbit, caused tetanic convulsions, emprosthotonos and opisthotonos alternating.

Cases of Poisoning by Laburnum (wood, bark, flowers, seeds, root).

(I.) SEEDS.

1.

"British Medical Journal," Jan. 22, 1870, p. 79 (Mr. Wheelhouse). Female: æt. 5½. Laburnum seeds. Eaten during 3 days.

Symptoms.—Symptoms of irritant poisoning; intellect clear; after a time there was slight drowsiness; extreme restlessness continued for 3 days, when she seemed to get better, but after two days more she became worse, the terrible restlessness being the most marked symptom.	*Result.*—Death in 6 days.	

2.

"Medical Times and Gazette," Sept. 13, 1862, p. 293 (Dr. Ussher), "Pharmaceutical Journal, Oct. 1852, p. 185. Male: æt. 11. Male: æt. 12. Cake flavoured with laburnum seeds.

Symptoms.—In one case there was vomiting, pain, muscular twitchings, dilated pupils, but no headache; clammy perspirations; became very sleepy and very cold; symptoms set in, in from 30 to 45 minutes.	*Result.*—Recovery.	

3.

Christison, p. 947 (Dr. Traill). 2 seeds.

Symptoms.—Insensibility; coldness of body; free vomiting was induced, and the next day the child was well.	*Result.*—Recovery.	

4.

Christison, p. 947 (Dr. Traill). Male: boy. Seeds.

Symptoms.—Complete insensibility; feeble pulse, and froth at mouth; (an emetic was given).	*Result.*—Recovery.	

5.

Christison, p. 947 (Dr. Bigsby). Female: child. Seeds.

Symptoms.—Vomiting; purging; recovery in 48 hours.	*Result.*—Recovery.	

6.

Christison, p. 947 (Dr. Annan). Male: boy. Seeds.

Symptoms.—Vomiting and drowsiness. For a month suffered from vomiting and diarrhœa.	*Result.*—Recovery.	

"Lancet," Sept. 18, 1869. Female: child. The seeds.

Symptoms.—Great pain.	*Result.*—Death.	

8.

"Lancet," Jan. 9, 1841, p. 52 (Mr. Bonney). (11 cases). (1) Male: æt. 9. 1 seed. (2) Male: æt. 9. 1 seed. (3) Male: æt. 9. 4 seeds. (4) Male: æt. 8. 4 seeds. (5) Male: æt. 6. 5 seeds. (6) Male: æt. 9. 1 seed. (7) Male: æt. 9. 5 seeds. (8) Male: æt. 8. 1 seed. (9) Male: æt. 7. 1 seed. (10) Male: æt. 8. 1 seed. (11) Male: æt. 7. 1 seed.

Symptoms.—Nos. 9, 10, and 11 scarcely suffered at all. No. 8 vomited and was soon well. No. 2 had well-marked dilated pupils. Nos. 7 and 8 vomited and were purged. Nos. 1 and 2 sleepiness. Nos. 4 and 5 a combination of all the symptoms. In the remainder there was merely nausea and feebleness of pulse.	*Result.*—Recovery.	

9.

"Lancet," Nov. 1, 1856, p. 497. Seeds.

Symptoms.—Twelve children at Otley (Yorkshire) were seized with rigidity of limbs from swallowing the seeds.	*Result.*—Recovery.	

10.

"Lancet," Sep. 16, 1871, vol. ii., p. 396 (Mr. Wilson). Male: æt. 4. 10 seeds.

Symptoms.—Vomiting in ½ an hour; in 2 hours drowsiness and convulsions; pupils largely dilated; pulse small; body cold; recovered the next day.	*Result.*—Recovery.	

(II.) BARK.

11.

"Lancet," Jan. 11, 1868, p. 55, Jan. 18, 1868, p. 86 (Mr. Wilson). Male; æt. 6. From chewing bark of laburnum.

Symptoms.—In about 6 hours symptoms of irritant poisoning set in; constant vomiting; slept between attacks of sickness; a fit came on before death, which occurred about 13 hours after chewing the bark of the tree.	*Result.*—Death in 13 hours.	*Post-mortem.*—Jaws clenched; pupils dilated; no inflammation apparent in the stomach, or in two-thirds of the duodenum, or in the large intestines, but from the lower part of the duodenum to the end of the ileum the inflammation was intense; blood fluid; lungs, heart, and brain healthy; none of the poison was found, as no doubt it had all been vomited.

12.

"Edinburgh Medical and Surgical Journal," Oct., 1843 (Sir R. Christison). Female. Some of the bark given by a young man in broth to a fellow-servant.

Symptoms.—Vomiting in 5 minutes, and continued for 36 hours, with pain, shivering, and purging. These last symptoms continued more or less for 8 months; at this time there was gastro-intestinal irritation; purging; bloody evacuations. She recovered eventually.	*Result.*—Recovery.	

13.

"Lancet," 1870, p. 182 (Mr. Tinley, Whitby). Female; æt. 18. Sucked a piece of bark.

Symptoms.—Felt unwell in half-an-hour. Next day there was pain, nausea, and thirst; dilated pupils; sense of fainting and exhaustion; no purging; recovered in 14 days.	*Result.*—Recovery.	

(III.) FLOWERS.

14.

"Guy's Hospital Reports," Oct. 1850, p. 219. Æt. 3. 12 laburnum flowers.

Symptoms.—Sickness and pain in 15 minutes; free vomiting of the flowers; no purging.	*Result.*—Recovery.	

15.

"Medical and Physiological Journal," vol. lxii., p. 86 (Mr. North). Female: æt. 4. Flowers.

Symptoms.—Convulsive twitchings of muscles of the face; cold skin; laborious respiration; attempts to vomit; (vomiting induced by emetics).	*Result.*—Recovery.	

(IV.) PODS.

16.

Taylor's "Medical Jurisprudence," vol. i., p. 444 (Mr. Rake). Two children. Æt. 2: æt. 3. Laburnum pods.

Symptoms.—Turned very pale, with slow pulse; pupils natural. Vomiting, when the seeds were ejected.	*Result.*—Recovery.	

(V.) ROOT.

17.

"Medical Times and Gazette," Jan. 3, 1857, p. 7 (Dr. L. Sedgwick). Male: æt. 8. The root eaten by mistake for liquorice.

Symptoms.—The boy vomited in 1½ hours; great giddiness and prostration; no pain, convulsions, or headache.	*Result.*—Recovery.	

18.

"Medical Times and Gazette," Jan. 3, 1857, p. 7 (Dr. L. Sedgwick). Female: æt. 10. The root eaten by mistake for liquorice.

Symptoms.—The girl had taken three times as much as the boy (in case No. 16). In 1 hour vomiting and great prostration set in; giddiness and drowsiness; no headache or convulsions.	*Result.*—Recovery.	

See for other Cases of Poisoning by Laburnum as follows:—

"British Medical Journal," Oct. 10, 1863, p. 408. Death.
"British Medical Journal," July 21, 1866, p. 86. Death.

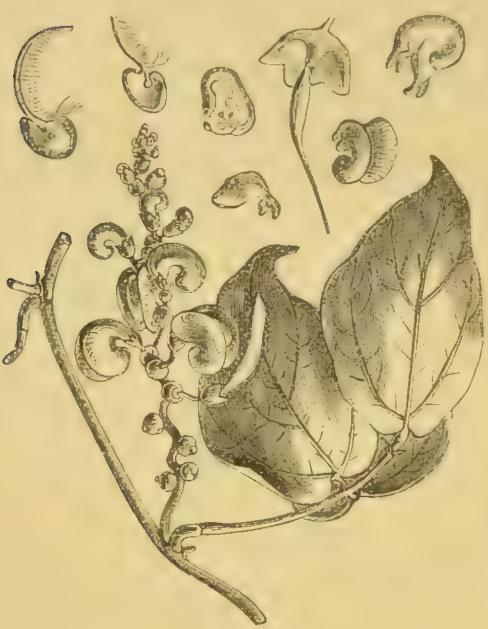
Physostigma venenosum. (Fig. 31.)

(The Ordeal Bean—Calabar Bean.)

The Calabar bean is sent to this country from Western Africa. It is known as the *Ordeal* bean, from the circumstance that the African natives compel people accused of witchcraft to drink a decoction of the bean, in the belief that if they are innocent, it will be vomited, but that if guilty, the poison will be retained, and cause death. ("British Medical Journal," Oct. 19, 1867, p. 341.)

Its use is almost confined to ophthalmic surgeons for effecting contraction of the pupil.

FIG. 31.



The bean, which is somewhat thicker than our garden bean, is about 1 to 1½ inches long, and ½ to ¾ of an inch wide, and weighs from 90 to 120 grains. It consists of two distinct parts :—(1) The outer shell, which is hard, brittle, and claret-coloured, weighing from 60 to 70 grains; and, (2), the kernel, which is white, without smell or taste, and weighing from 30 to 50 grains. Touched with *nitric acid*, it becomes orange, and with *perchloride of iron*, brown. This white portion is the active part of the bean, its activity being due to an alkaloid, called Physostigmine. About 2·7 per cent. of the bean is soluble in alcohol, the undissolved portion being physiologically inert.

Physostigmia.

(Physostigmine Eserine—Esserina.)

This alkaloid exists exclusively in the cotyledons. It is a colourless, crystalline solid, somewhat bitter, and without smell. Bentley and Redwood state that it is a yellowish brown or red amorphous body.

Water dissolves it very slightly, but it is freely soluble in alcohol, ether, chloroform, or benzol. It forms salts with acids. Its reactions are as follows :—

(*a*) Its solution in water, after caustic soda or potash has been added, will, upon exposure to air, change in colour to a green or blue.

(*β*) A red colour is produced, on adding to the solution either bromine-water, or bromine in bromide of potassium (Dragendorff).

(*γ*) It is stated that the nascent oxygen tests produce somewhat similar results to those of strychnia (Dr. J. B. Edwards). This statement, however, requires further investigation. Of all tests for Physostigmia, or for the Calabar bean, the physiological test is by far the most delicate and important. The merest trace, dropped into the eye of a rabbit, causes contraction of the pupil in from ten to fifteen minutes.

Experiments on Animals.

For these we are indebted mainly to Dr. Fraser ("Edinburgh Royal Society Transactions," vol. xxiv.), and to Sir R. Christison ("Pharmaceutical Journal," 1855, p. 474). Christison found that twenty-one grains of the powder given to a dog produced great and immediate weakness, paralysis after about four minutes, and death in five. Slight muscular twitching was observed. In a second case, two grains of the alcoholic extract produced immediate weakness, paralysis in two minutes, and death in three.

Fraser has examined the symptoms produced by the poison with great minuteness. He finds it proves fatal to every animal except the Esere moth.

A *large dose* produces instantaneous paralysis of the hind legs, contracted pupils, increased secretion from the mouth and nose, whilst an absence of reflex action is noticeable. The paralysis spreads rapidly to the muscles of respiration, and the animal dies quickly. After death the pupils dilate.

A *smaller, but fatal dose*, produces at first a slight tremor of the hind legs, passing on to complete paralysis. The urine and fæces pass involuntarily. The pupils contract, and frothy mucus flows from the mouth. The animal remains conscious; but reflex action seems entirely gone. Muscular twitchings have been generally noticed, amounting at times almost to convulsions. The breathing before death becomes stertorous and gasping. The pupils dilate after death.

It has been noticed with large doses (except they are very excessive, when actual cardiac paralysis may be produced) that the heart retains its irritability for some time after death, whilst after poisoning by moderate doses the muscles contract when cut, and the vermicular action of the intestines continues for some time. The lungs are invariably gorged.

These experiments prove that the Calabar bean belongs to the same class as conium, and kills by apnœa. It will be noted that, physiologically, it has a strictly reverse action to strychnia: strychnia being a true spinal excitant, and Calabar bean a direct spinal depressant. For this reason the Calabar bean has been given in tetanus.

Symptoms.

For our knowledge of the symptoms we are mainly indebted to some dangerous experiments made by Sir R. Christison on himself. On taking six grains of the seed, he states that he felt no effect, except a little numbness; but that when he ventured on twelve grains, he felt giddy and drowsy after twenty minutes. He then took an emetic; but although it acted freely, the giddiness increased, and was accompanied by extreme faintness and prostration. The heart was feeble and irregular, but he suffered neither pain, numbness, nor pricking. The mind was perfectly clear. With stimulants Sir Robert got better, and was able to move about a little; but after a time, feeling a desire to sleep, he was allowed to doze for two hours. The sleep he describes as "conscious sleep;" so much so, that upon awaking, he did not know he had been asleep at all. Next day he felt quite well.

The symptoms of a poisonous dose may be thus stated:—First, there is giddiness, passing on to paralysis of the voluntary muscles. Often there are muscular twitches of a convulsive nature, and invariably contraction of the pupil, preceded by myopia. The mind is generally clear. At last, if the case ends fatally, the respiratory muscles become affected, and the person dies asphyxiated.

Respecting the contraction of the pupils, Bouchardat found that one drop of the extract applied to the eye of an animal produced contraction of the pupil in from ten to fifteen minutes. And this will be the great diagnostic symptom, distinguishing the action of the poison from that of atropia, conia, daturia, or hyoscyamus.

"La France Médicale" states that M. Bouchat has given it in doses of 2 to 5 milligrams (= $\frac{1}{33}$ to $\frac{1}{13}$ of a grain) 437 times, either by mouth, or subcutaneously, in cases of chorea occurring in young girls, aged eight to twelve years He finds that the disease requires ten days' treatment on an average by this method. The larger dose (administered subcutaneously) produced pain, tendency to cry, desire to vomit hindered by the almost complete paralysis of the diaphragm, sweating, cramps, and loss of muscular power, without any affection of sensation or intelligence. The choreaic movements were checked, and never recurred so violently. These symptoms lasted about three hours. Neither contraction of the pupils, nor the convulsions noticed in animals were observed. Although the pupils were carefully noted, they were only found to be small in two cases. Small doses produced vomiting, but the paralysis of the diaphragm, &c., was less marked. About $\frac{1}{25}$ of a grain seems a useful dose for a child of ten or twelve years, (= 3 milligrammes,) and may be given twice or three times in the course of the twenty-four hours.

As regards the state of the pupils, *see* the note to Morphia (*àpropos* of the celebrated "Affaire Castaing").

Six of the beans have proved fatal to a boy, aged six.

Treatment.

Emetics and the stomach-pump must be used. From their antagonistic action it has been recommended to inject one-thirtieth of a grain of atropia hypodermically, gradually increasing the dose, until dilatation of the pupils is induced. So far as the pupil is concerned, of course there is a direct antagonism between these two bodies; but we do not consider that such treatment is allowable.

Cases of Poisoning with the Calabar Bean.

1. "Lancet," Aug. 27, 1864, p. 245; "Medical Times and Gazette," Aug. 15 and 20, 1864. Seventy children in Liverpool eat some beans which had been swept up in a ship that had come from Africa. One boy, æt. 6, who had eaten six beans, died.		
Symptoms.—There was pain; vomiting; staggering as if intoxicated, and contracted pupils.	*Result.*—Death.	
2. "Edinburgh Monthly Journal," 1864, p. 193. Æt. 6. Eat the kernel of one nut.		
Symptoms.—Sickness in 40 minutes; sleepiness; hands powerless; staggering, pain in stomach; pupils contracted. Recovered on third day.	*Result.*—Recovery.	
3. "Edinburgh Monthly Journal," 1864, p. 193. Æt. 3. Eat the kernel of one nut.		
Symptoms.—Sleepiness, depression, and pain in the abdomen; pupils and pulse natural; purging. Recovered on third day.	*Result.*—Recovery.	

21. LILIACEÆ.

Aloe vulgaris, &c.
(Barbadoes and other Aloes.)

"Aloes" is the inspissated juice issuing from the cut leaves of the different species. "*Barbadoes* aloes" has a dull, brown colour, a bitter taste, and a nauseous odour; "*Socotrine* aloes" has a bright red colour, a bitter taste, and a faint, but somewhat agreeable odour.

Aloes is an ingredient of most quack pills; as, *e.g.*, "Morrison's Pills;"* as well as of "the Holy Bitter" ("Hiera Picra," or "aloetic powder"), which consists of four parts of aloes, and one of canella bark. The hiera picra has been usually taken for the purpose of effecting abortion. (Reg. *v.* White, Aylesbury Assizes, 1857.) The aloes is the chief ingredient that possibly may act on the uterus, not however by any specific influence, but by its action upon the lower bowel, and the general upset that it causes to the constitution.

Aloes dissolves in spirit, crystals after a time being precipitated.

In all varieties the active principle of the drug is—

Aloin ($C_{34} H_{36} O_{14} H_2 O$).

Aloin is a neutral body, and is found in that portion of the aloes, which is soluble in water.

It crystallizes in the form of needles.

It is a glucoside. By the action of acid, glucose and aloetic acid is formed. A second glucoside is also present in that portion of the aloes which is insoluble in water.

Cold sulphuric acid turns it yellow, the colour changing to green when warmed. Nitric acid turns it orange, polychromic and other acids being formed.

Aloes also contain a resin, which, unlike most resins, is soluble in boiling water. It is probably oxidized aloin.

There is also an acid present (aloetic acid), which strikes an olive brown, with persalts of iron.

Aloes is an irritant poison, and acts as a drastic purgative. Death will be due mainly to exhaustion by excessive purging.

Case of Poisoning by Aloes.

Taylor's "Medical Jurisprudence," vol. i., p. 325. (Occurred in Germany.) Female: æt. 43. ʒij of powdered aloes.		
Symptoms. — Violent purging and death.	*Result.*—Death in 12 hours.	*Post-mortem.*—Stomach and the small intestines extensively inflamed.

Squilla Maritima.
(Squill.)

The squill is a narcotico-acrid poison. It contains, according to Landerer, an active alkaloidal principle, called *Scillitin*, one grain of which is said to have killed a dog. Orfila found that 2½ ounces of the fresh root, secured in the stomach of a dog, killed it in two hours, death occurring in a fit of tetanus. Coma, dilated pupils, and general convulsions were also noticed. Thirty-six grains injected into the jugular vein killed a dog in sixteen hours. Christison records bad effects being produced with ¼ ounce of the syrup of squills.

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* Fatal Cases said to be produced by Morrison's Pills are recorded ("Lancet," Sept. 8, 1838, p. 846; "Lancet," July 20, 1839, p. 635).

Both the powdered root and the extract have caused death.

Cases of Poisoning by Squill.

<table>
<tr><td colspan="3">1.
"Toxicologie Gen.," vol. ii, p. 202 (Lange). Female: adult. A spoonful of powdered root taken to cure tympanitis.</td></tr>
<tr><td><i>Symptoms.</i>—Immediate pain; convulsions.</td><td><i>Result.</i>—Death.</td><td><i>Post-mortem.</i>—Stomach inflamed, and in some parts eroded.</td></tr>
<tr><td colspan="3">2.
"Journal de Chimie Médicale," 1842, p. 651; and "Medical Times," Oct. 29, 1842, p. 78. Female. 75 grains of the extract as an alcoholic tincture.</td></tr>
<tr><td><i>Symptoms.</i>—Nausea and colic; after 24 hours pupils contracted; extreme abdominal tenderness; coldness of extremities; death.</td><td><i>Result.</i>—Death on 2nd day.</td><td></td></tr>
</table>

22. LOBELIACEÆ.

Lobelia Inflata, and other Varieties.

(Lobelia, Indian Tobacco, Bladder-podded Lobelia.)

The *stem* of the Indian tobacco is angular; the *leaves* are hairy on their under surface; the *seeds* are light brown, and hairy (3176 to 1 grain: Guy), of an oval shape, and reticulated on the surface.

It is imported from North America, in the form of compressed oblong cakes, which are sent over by the shaking Quakers of New Lebanon, and are principally used by the quack botanical doctors, who revel in the ominous name of "Coffinites." Coffinism is no innocent, harmless system. Its absurd theory is, that "Heat is life; and the want of heat disease;" and so Cayenne pepper and lobelia are the two principal medicines of its professors ("Lancet," June 22, 1850, p. 766; and July 6, 1850, p. 31), which they administer with no cautious or measured hand. Over and over again they assert, what has over and over again been disproved, that lobelia cannot kill.

Lobelia is generally found in the form of a greenish-coloured powder, consisting chiefly of the powdered seeds. It has a disagreeable smell, and a nauseous acrid taste, which is not developed until a short time after it has been put into the mouth. The taste is due to the presence of an alkaloid (lobelin), a volatile oil, and a peculiar acid (lobelic acid).

Lobelin, or Lobelina.

This was first isolated by Bastick. It is a yellowish liquid, lighter than water, and has an acid taste, and an aromatic odour.

It is slightly soluble in water, and freely soluble in alcohol and ether. It has an alkaline reaction, and forms salts with acids.

Symptoms—Dose.

In small doses lobelia acts as an expectorant, but in larger doses as an emetic.

In poisonous doses the symptoms closely resemble those of tobacco. There is severe vomiting, with intense depression and prostration, headache, giddiness, tremor, and often insensibility. The patient becomes bathed in cold sweats. The pupil is ordinarily contracted. Diarrhœa and dysuria are not uncommon. The pulse is generally intermittent, and convulsions usher in death.

But, on the contrary, the patient often gets well; and the reason is quite obvious. So long as vomiting is produced, all will be right; but when this becomes impossible, either by reason of the prostration of the system by disease or old age, or, the reverse of this, its administration to infants and very young children, then it is that vomiting is not induced, and there is nothing left for the wretched patient but death. And the conclusion is forced upon us, that lobelia, in the hands of men—as careless as they are ignorant—is a most dangerous drug.

As regards dose, ten to fifteen grains of the powdered leaves or seeds will act as a strong emetic. A dram has destroyed life, although, as we have said, recovery may occur from very large doses if free vomiting be produced. One-half to one grain of lobelin is a dangerous dose; but it appears that the alkaloid does not act so much as an irritant, as a narcotic. Death sometimes takes place very slowly.

Post-mortem Appearances.

The stomach and bowels are generally inflamed, and the vessels of the brain congested.

Treatment.

Vomiting must be immediately produced, and stimulants given, in order to prevent the depressant action of the drug.

In a toxicological examination search should be made specially for portions of the seeds, which must be examined microscopically. The leaves are not very characteristic. Nitric acid turns the powder of lobelia red, and sulphuric acid chars it.

Cases of Poisoning by Lobelia.

1. "Pharmaceutical Times," May 1, 1874, p. 182. Male. ʒj of powdered leaves given by a quack.		
Symptoms.—Great pain; insensibility; small pulse; contracted pupils; vomiting: spasmodic twitchings of the face; death in 36 hours.	*Result.*—Death in 36 hours.	*Post-mortem.*—Nothing found in the stomach; mucous membrane of stomach very inflamed; vessels of brain congested.
2. "Medical Times and Gazette," Nov. 26, 1853, p. 568 (Dr. Letheby). (1) Male: æt. 27. Lobelia seeds given by a Coffinite.		
	Result.—Death.	*Post-mortem.*—Stomach highly injected.

3.

"Medical Times and Gazette," Nov. 26, 1853, p. 568 (Dr. Letheby). (2) Lobelia given by a Coffinite.

	Result.—Death.	*Post-mortem.*—Stomach inflamed.

4.

Bigelow's "American Botany," vol. i., p. 181 (case of Ezra Lovett). Lobelia powders given by a quack.

Symptoms.—In the first instance the powders were given, and induced vomiting; but afterwards vomiting did not set in, and serious symptoms consequently ensued; delirium and convulsions.	*Result.*—Death.	

5.

"Lancet," 1869 (Dr. Tidy and Mr. Rees Llewellyn). Æt. 1. Lobelia given by a quack.

Symptoms.—Violent sickness; cold sweats; convulsions.	*Result.*—Death.	*Post-mortem.*—Stomach very inflamed; no lobelia found.

6.

"Lancet," Sept. 8, 1849, p. 275 (Reg. *v.* John Wood). Male. Given internally, and used as an injection (=120 grains internally and 120 grains by injection).

	Result.—Died in about 36 hours.	*Post-mortem.*—Stomach greatly inflamed, especially at the cardiac orifice; great and small intestines more or less inflamed; an ulcer found in the jejunum; congestion of the brain.

See the following Cases also recorded of Poisoning by Lobelia:—

"Medical Times and Gazette," March 12, 1853, p. 271 (Dr. Letheby).
"Medical Times," June 30, 1849, p. 684 (Death from lobelia powder given by a Coffinite).

23. LOGANIACEÆ.

Gelsemium Sempervirens.

(Yellow Jasmine.)

The alcoholic extract of the root has proved poisonous. It contains an alkaloid, gelseminine (Wormley), and an organic acid, gelseminic acid.

Gelseminine is an active poison. One-eighth of a grain killed one rabbit when administered hypodermically in one and a half hours, a second in fifteen minutes, and a third in forty minutes. No convulsions were produced. The pupils were dilated.

Gelseminic Acid is fluorescent when dissolved in potash. By the action of nitric acid it changes to a light red color, which becomes blood-red when acted upon with ammonia.

Dr. Wormley states that it may be detected in the stomach months after death.

Case of Poisoning with the Yellow Jasmine.

"American Journal of Pharmacy," Jan., 1870. Female: adult, pregnant. Three teaspoonsfull of fluid extract = 480 grs. to oz.

Symptoms.—In 2 hours pain in stomach; nausea; dimness of vision; became very restless; skin perspiring; in 4 hours pulse feeble and irregular; prostration; slow and irregular breathing; skin became dry; limbs cold; pupils dilated and insensible, and eyes fixed; no convulsions; death.	*Result.*—Death in 7½ hours.	*Post-mortem.*—Brain and spinal cord normal; lungs natural; heart normal, the superficial veins being injected, and the cavities distended with dark grumous blood; left kidney congested; stomach, intestines, and peritoneum healthy.

Strychnos Nux Vomica.

The bark of the strychnos nux vomica, which is very poisonous, has been more than once substituted for angustura bark (Galipea Cusparia), and called False Angustura Bark. The extreme bitterness of the nux vomica bark, its twisted appearance, the impossibility of separating it into thin layers, and the blood-red colour produced when nitric acid is applied to the internal coat, renders it easy to distinguish the one from the other. And further, in true angustura bark the external surface is covered with a yellowish grey uneven epidermis, the internal coat being of a light brown colour, whilst the epidermis of the false angustura or nux vomica bark is white, and spotted with red dots.

Nux Vomica Seeds.

The fruit of the nux vomica is very similar to an orange. The *seeds* are of a light brown colour, round, flattened, and about the size of a shilling, one side being convex, and the other concave. They have a velvety feel from their being covered with fine hairs. They have no smell, but their taste is intensely bitter. They are very hard, and difficult to pulverize.

Two preparations of them are to be found in the "Pharmacopeia :—

1. *Extractum Nucis Vomicæ :* 1 lb. of seeds yields 1½ oz. of extract.
2. *Tinctura Nucis Vomicæ :* ℥ij of powdered seeds to 1 pint of spirit.

The seeds have been called by the Germans "Crows' Eyes," from their supposed similarity. Some time back one of the authors was consulted respecting the composition and properties of a seed, which had in every respect a striking resemblance to nux vomica. It was the seed of a foreign cucurbitaceous plant, and was found not to be poisonous.

The powdered seeds are often met with in the shops, and have more than once been taken and administered criminally. The symptoms, treatment, and post-mortem appearances do not differ materially from strychnia. In conducting an investigation in a case of poisoning by the powdered seeds, the sediment of the contents of the stomach, and particularly the scrapings from the lining membrane of the stomach, must be carefully examined for portions of the seed. These may be easily identified, even when the pieces are very minute, by the fine silken hairs projecting from their surface. An aqueous solution of nux vomica turns red when treated with nitric acid, the colour being discharged by chloride of tin. It also turns green when treated with perchloride of iron. It is precipitated by tincture of galls. Search must be especially made for strychnia in the manner to be afterwards described.

Under ordinary circumstances one of the seeds, or about thirty grains, is sufficient to cause death. In the treatment the stomach-pump should be actively employed, in order to displace the particles adhering to the sides of the stomach.

Woorara Poison.

It will be convenient here to refer to what is known as the Woorara poison, which is believed by most toxicologists to owe its poisonous action to the presence of strychnia, although there is some doubt whether this be the case or not.

The Woorara poison is known by several names—such as *Curari* (Humboldt); *Woorara* (Bancroft, in 1769); *Woorali* (a corruption of Woorara); *Ticunas* (the name of a tribe who prepare the poison); *Urari* (Raleigh.)

The Woorara poison has been a subject of lively discussion. Many have believed that its active ingredient is the poison of serpents. Dr. Taylor and Schomburgk state positively that it contains strychnia, the latter asserting that he has succeeded in tracing its source to the strychnos toxifera. On the other hand, Dr. Cogswell states ("Lancet," March 3, 1855, p. 243), that in his experiments the symptoms produced by it were very different to those of strychnia poisoning; whilst M. Vella asserts not only that the Woorara does not contain strychnia at all, but that it is an antidote for strychnia. ("Medical Times and Gazette," Oct. 13, 1860, p. 357.) Dr. Cogswell's experiments are interesting. He found it to be very fatal when swallowed, although Brodie and others held and asserted a contrary opinion. Introduced beneath the skin of a frog's leg, he found that it caused paralysis of the limb. Its primary action, Dr. Cogswell states, he believes to be narcotic; but that it acts secondarily as a sedative, paralyzing the functions of the nervous system, and this both locally where it is immediately applied to the body, and constitutionally after it has entered the circulation.

The poisonous action of the Upas Tieuté is believed to be due to strychnia.

"The Woorara poison is brought to Europe in calabashes as a brown powder, which dissolves in water, producing a red-coloured solution, having an acid reaction, and bitter taste, and giving no precipitate with alkalies. Others describe it as a black, shining, resinous mass, which dissolves in water and alcohol, and evolves a nitrogenous odour when heated. It contains an active principle, as well as fatty, resinous, and red-colouring matters, and some ash. When a small quantity of this substance is introduced into the system through a scratch in the skin, death rapidly follows. South American travellers have given conflicting accounts both of the preparation and action of the poison; but they all agree in the statement that the flesh of an animal killed by a curarized arrow is quite wholesome, as the poison has no effect when swallowed.

"The active principle was first isolated in an impure uncrystallizable state by Boussingault and Roulin in 1830: it was afterwards examined by other chemists; but it was first obtained as crystals by Preyer in 1865. By extracting curara with alcohol, distilling away the alcohol, dissolving the residue in water, adding corrosive sublimate, and decomposing the compound formed, hydrochloride of curarine was obtained. *Curarin* itself crystallizes in colourless four-sided prisms, which have a bitter taste, are very hygroscopic, and dissolve readily in alcohol and water the solution being alkaline, but not in ether or benzol, and but sparingly in chloroform. The formula assigned to the base is $C_{10} H_{15} N$. It forms salts with the mineral acids, which crystallize, but are very soluble in water. Many experiments have been made to determine the action of this poison; and it now seems certain that it paralyzes the nerves of motion, and that an animal under its influence dies of suffocation from paralysis of the muscles of the chest. The minutest quantities of the pure base produce toxic or even fatal symptoms, 0·015 of a grain being fatal to a rabbit, and 0·004 to a frog, when injected under the skin. Curarine, which has been taken into the stomach, seems to be eliminated almost unchanged. If after administration of curarine, life be maintained by artificial respiration, symptoms of *diabetes mellitus* are perceived, and the urine contains sugar."

The above account is taken almost verbatim from the "Popular Encyclopædia," p. 676, vol. ii. But the authors are able of their own knowledge to confirm all these remarks on the effects of the poison.

Strychnia ($C_{21} H_{22} N_2 O_2$).

Strychnia was discovered in 1818 by Pelletier and Caventou, in the seeds of the strychnos nux vomica, and strychnos Ignatia (S. Ignatius' bean). The quantity present varies from 0·5 to 1 per cent. It is now known to exist in at least five species of the genus strychnos, and in each case is found associated with another alkaloid, brucia ($C_{23} H_{26} N_2 O_4$). In strychnos nux vomica a third alkaloid has been disovered, called Igasuria, with probably other bases (Schutzenberger), all of which are combined with strychnic, igasuric, and lactic acids. Several species of the strychnos contain no trace of the alkaloid strychnia.

1. *Strychnos Nux Vomica*, a tree. (India and Ceylon.)
2. *Strychnos Ignatia*, a tree. (Philippine Islands.)
3. *Strychnos Tieuté*, a shrub. (Java.)
4. *Strychnos Toxifera*, said to be one compound of the Woorara poison. (Guiana.)
5. *Strychnos Colubrina*, a tree. (Asia.)

Physical Properties.

Strychnia is found either in the form of a white powder, or else in crystalline particles of different magnitudes and of variable appearance. Sometimes the crystals are in little pearly scales, like mica; at other times they are octahedra with a rhombic base, although they are somewhat more commonly found as large four-sided prisms. The crystalline forms vary according to whether they are obtained from an ethereal or alcoholic solution.

Strychnia has been more than once mistaken for santonine, to which it has some similarity. ("British Medical Journal," Oct. 12, 1861, p. 400; "Lancet," 1870, p. 598, vol. i.) It has no smell; but its taste is so intensely bitter that it may be detected in an aqueous solution containing a grain of the alkaloid in the gallon, or in a single drop of water which contains not more than one part in 5000. The salts of strychnia are not so bitter as the alkaloid.

Of all the common salts of strychnia, the acetate is by far the most soluble in water and alcohol, although not so soluble in ether. When a drop of a solution of any salt of strychnia is allowed to evaporate spontaneously on a slip of glass, the crystalline forms can be easily identified under the microscope. They are invariably found either in the form of plumose tufts of acicular crystals, radiating from a centre, or as long, flat needles, or as thin rectangular plates.

The solubility of strychnia in different liquids, and the forms of the crystals produced from the various solutions, on allowing the solvents to evaporate spontaneously, are recorded in the following table :—

Solubility of Strychnia in different Liquids, and forms of Crystals obtained.

1 gr. of Strychnia dissolves in	7,000 of Cold Water (16° Cent.) . .	Crystals small, and very indistinct, appearing to the naked eye when seen in quantity to be nodular.
1 gr. of ,, ,,	2,500 of Boiling Water (100° Cent.) . .	
1 gr. of ,, ,,	1,000 of Bisulphide of Carbon . .	Residue white and granular ; forms indistinct.
1 gr. of ,, ,,	340 of Ether . .	Crystals appear as flat prisms, sometimes small and serrated.
1 gr. of ,, ,,	250 of Benzole . .	Crystals very large, sometimes octahedral.
1 gr. of ,, ,,	100 of Alcohol . .	Crystals brilliant and sparkling ; modified rectangular, and rhombic prisms ; the opposite acute angles being often replaced by planes. Size of crystals dependent on quantity, but always well formed.
1 gr. of ,, ,,	30 of Dutch Liquid	Residue reddish, and not very crystalline, when only a small quantity of strychnia is present ; but when there is a considerable amount, the crystals are large, long rectangular prisms.
1 gr. of ,, ,,	10 of Chloroform .	Crystals not well formed ; but sometimes occur in rosettes and tufts.

Chemical Properties.

Strychnia cannot be volatilized in an unchanged condition. It has distinct basic properties, and readily forms crystallizable salts, which are for the most part soluble both in water and alcohol. It is not decomposed either by the cold concentrated mineral acids, or by the caustic alkalies. The mineral acids dissolve it, but no change of colour results from their action. The power that strychnia possesses of resisting the decomposing action of strong acids is remarkable. Sulphuric acid may be kept in contact with it for months without apparently affecting it. It remains unaltered, too, both in the presence of the most active fermentation, and in the prolonged putrefaction of organic bodies.

Impurities of Strychnia.

Brucia is often used as an adulterant. It may be known by adding nitric acid, which produces no discoloration with strychnia when pure, but if brucia be present, an intense red colour will be immediately developed.

Strychnia is largely used in the various forms of "Vermin Killers," mixed with different colouring matters. It may generally be easily extracted from these with alcohol, and the colouring-matter got rid of by strong sulphuric acid. "Battle's Vermin Killer" contains 23 per cent. of strychnia, mixed with sugar, flour, and Prussian blue; "Butler's Vermin Killer" contains about 5 per cent. of strychnia, mixed with flour and soot; "Gibson's Vermin Killer" contains about 0·5 grain of strychnia in each powder. A curious case is recorded, where about 150 pheasants were poisoned from eating the maggots generated in some animals destroyed by a strychnia vermin killer. ("Lancet," Aug. 23, 1856, p. 231.)

Symptoms—Dose, &c.

From the records of twenty-seven cases, where the time of the commencement of the symptoms is recorded, we learn that—

In 2 Cases	the Symptoms set in	directly.
In 2 ,,	,,	in 3 minutes.
In 2 ,,	,,	in 5 do.
In 4 ,,	,,	in 10 do.
In 5 ,,	,,	in 15 do.
In 5 ,,	,,	in 20 do.
In 2 ,,	,,	in 30 do.
In 1 Case	,,	in 45 do.
In 1 ,,	,,	in 1 hour.
In 1 ,,	,,	in $1\frac{3}{4}$ do.
In 1 ,,	,,	in 2 hours.
In 1 ,,	,,	in 3 do.

Thus it would seem that the most usual time for the symptoms to commence is in from ten to twenty minutes, but that they may begin immediately, or be delayed for an hour or more. Such variations depend both on the form in which the poison is taken, and on the manner of its administration. The action is rapid, if the strychnia be given in solution, and slow when it is administered in the form of a pill, more particularly if that pill be old and hard. The patient will probably complain first of all of the hot bitter taste of what he has swallowed. He will cry out for the window to be thrown open, from a feeling of impending suffocation. The strychnia fit soon comes on, when the muscles will be seen to jerk, and an intense stiffness of the body, with severe tetanic convulsions, will rapidly supervene. The legs will be jerked out violently and frequently, the feet being generally everted and arched, and the toes drawn under the feet. Opisthotonos (that is, where the head and the heels constitute the only supports of the arched body), is a frequent form of the tetanic spasm of strychnia. The pain is intense, and the distress arising from the muscular contractions of the whole body, and more particularly of the abdomen, seems absolutely intolerable. Vomiting is not common. The chest appears fixed, and there is a constant gasping respiration. The face usually appears to be in a broad grin. The eyes are often prominent, the pulse rapid, and foam issues from the mouth. This is the fit, and it generally lasts for a minute or two. During the fit the pupils are dilated. After a few minutes a remission of all the symptoms occur, when the pupils contract, and the patient, bathed in sweat, seems worn out by the agony he has endured. The remission may last from a few minutes to half an hour, when another fit similar to that already described will set in. The prominent symptom, however, of strychnia poisoning is *tetanus* or lock-jaw ; and this is not merely an accidental symptom, as when it happens in other cases of poisoning, but is invariably present. It must too be noted particularly that in strychnia poisoning the jaw is the last part to be affected. In the remission even the tetanus may subside ; but, although the patient appears to be dying of thirst, to drink a drop of liquid seems impossible ; for in the attempt, or by a touch of the finger of a bystander, or by any effort of the patient, or by neither the one nor the other, and often apparently without cause, the fit returns. The time it lasts gradually increases, whilst the remissions become fewer and shorter ; until at length the patient dies, either from asphyxia during a paroxysm, or from intense exhaustion during a remission, and probably within two hours of his having taken the poison. As a rule the patient's mind is clear to the end, conscious of his danger, and terrified at the return of the fits. (For modes of death in strychnia poisoning, see "Lancet," July 19, 1856, p. 72.) As regards prognosis, the records of cases prove that death or recovery is always rapid, and that if a person lives over five or six hours, the case is hopeful.

The records of 32 fatal cases show that—1 died directly, 2 in 10 minutes, 1 in 15 minutes, 3 in 20 minutes, 6 in 30 minutes, 1 in 45 minutes, 5 in 1 hour, 6 in from $1\frac{1}{4}$ to $1\frac{3}{4}$ hour, 3 in from 2 to $2\frac{1}{2}$ hours, 2 in $3\frac{1}{2}$ hours, 1 in 5 hours, and 4 in 6 hours.

The $\frac{1}{12}$th to the $\frac{1}{30}$th of a grain is commonly regarded as the medicinal dose of strychnia. We usually consider that $1\frac{1}{2}$ to 2 grains and upwards is a poisonous dose. Andral reports a case of severe tetanus being produced by the $\frac{1}{12}$th of a grain ; whilst a fatal case is recorded as having occurred from a quarter. Gallard considers that even $\frac{1}{6}$th of a grain should be regarded as a poisonous dose. ("Medical Times and Gazette," Oct. 18, 1862, p. 416.)

But numerous cases are on record of recovery after taking large doses, such as even 40 grains ("Medical Times and Gazette," Sept. 2, 1865, p. 267); whilst several cases of recovery from 1, 3, 4, 7, 10, 15 and 20 grains, will also be found in the list of cases.

Strychnia is far more intense in its action when administered hypodermically, than when given by the mouth.

A very important question has been raised, namely, whether an infant can be poisoned by strychnia through the medium of its mother's milk? Dr. Letheby, at an inquest on a case of poisoning ("Lancet," May 15, 1869, p. 683), replied to this question, that he thought it was possible. In the "Lancet" of May 22, 1869, p. 732, Dr. George Harley records a case, showing (1) that a child may have distinct tetanic symptoms by sucking the milk of a mother who was taking strychnia in medicinal doses ; and (2) that the toxic effects on the child may be present without any corresponding effects on the mother. "If, then," Dr. Harley says, "a child can receive sufficient strychnine in its mother's milk to bring on tetanic spasms, in a case where the mother is taking medicinal doses so small that she herself remains physiologically unaffected by the drug, are we not justified in concluding that in a case where a mother has taken sufficient to be poisoned, her offspring at the breast may die from the effects of the alkaloid, although she herself may recover?" A second similar case is also recorded ("Lancet," June 19, 1869, p. 872) by Mr. Lewis.

Dr. N. Gorochofzeff, of Orenburg, concludes from his experiments on dogs that the poisonous effects of strychnia are stronger and more rapid when introduced into the cavity of the mouth than they are in the stomach. Half a grain of sulphate of strychnia introduced into the mouth of a dog, after the ligature of the œsophagus, proved fatal in four minutes, whilst a similar dose when allowed to reach the stomach proved fatal in fifty minutes. Death, he considers, is not caused by absorption of the poison when introduced into the mouth, as no traces of strychnia could be found in the blood.—("Rev. des Sciences Méd.," May, 1875, p. 57.)

Post-mortem Appearances.

There is little to be said respecting post-mortem appearances. What has been noticed, if we except the state of the brain and spinal cord, is neither uniform nor characteristic. Post-mortem rigidity is usually prolonged. The countenance after death is, as a rule, natural, but indicative of more or less suffering. The state of the heart varies. In most of the cases that have come under our own observation, we have found the heart full of blood on both sides, but particularly on the right side; whilst we have on the other hand, found it more than once empty and contracted. Too much reliance, we are convinced, must not be placed on the state of the heart as a characteristic post-mortem appearance. Dr. Geoghegan states that in six out of ten inspections of fatal cases made by him, he found the heart either contracted or wanting in normal fulness. As a rule, nothing specially characteristic will be noticed in the appearance of the stomach, but occasionally it will be found intensely congested. If, however, there is one specially characteristic morbid appearance of death by strychnia it is, as we have said, the intense congestion both of the brain and spinal cord, with considerable effusion of blood. But even these appearances are not constant. Very often, too, considerable congestion of the air-passages will be observed.

Treatment.

To get the poison out of the system is the first great indication, and for this purpose we must use the stomach-pump. The injection of powdered animal charcoal for the purpose of absorbing the poison is strongly recommended, and with considerable reason. The charcoal should be allowed to remain in the stomach for about five minutes, and then be pumped out, and a fresh quantity injected. Some difficulty will probably be experienced in the introduction of the pump, from the fixed state of the jaw. Immediately therefore you are called to a case of strychnia poisoning, administer chloroform, and when the patient is thoroughly under its influence, you will probably be able to introduce the tube of the pump without difficulty. And what is more, the chloroform offers the greatest chance of relief, and appears to be the best practicable means of keeping in check the violence of the fits (Dr. Sabarth, "Dublin Medical Journal," 1867, vol. xliii. p. 167). At the same time it is right to note that Professor Pilwax asserts, that, in his experiments upon animals to which strychnia had been administered, chloroform proved useless as an antidote ("Medical Times and Gazette," Jan. 9, 1858, p. 44).

The thirst, if the patient can take drink, is best relieved by strong tea.

Numerous remedies have been suggested.

Opium and morphia are much commended by some, and cases on record show that they have proved useful. Mr. Mavor's experiments ("Lancet," Dec. 9, 1871, p. 840), are interesting in illustration of the antagonism between strychnia and opium. *Camphor* is also much recommended, and has certainly proved of value ("Lancet," July 24, 1852, p. 80). *Nicotine* is believed by Professor Haughton to be of immense service ("Dublin Quarterly Journal of Medical Science," August, 1862).

Dr. Ananoff, of Tiflis, in studying the therapeutic value of oxygen, found that in animals poisoned by strychnia *the inhalation of pure oxygen*, by aid of artificial respiration, successfully counteracted the effects of the poison ("Echo de la Presse Médicale," Paris, Aug., 1874, p. 64.)

Tannin has been specially applauded by M. Kurzak, provided it be administered in a quantity not less than twenty to twenty-five times that of the poison swallowed ("British Medical Journal," December 13, 1862, p. 620).

Prussic acid is recommended by some, but we scarcely regard the experiments recorded as of much value in asserting its antidotal power ("Lancet," vol. I., 1868, pp. 275-335).

Common salt has also been suggested ("British Medical Journal," July 27, 1867, p. 63).

Lastly, we have to refer to *Chloral Hydrate.* There can be but little doubt that this is a most useful drug in strychnia poisoning, and seems, so far as it has been tried, to have acted more satisfactorily than anything else. It should either be given in full doses and repeated as often as necessary, or if its administration by the mouth be impossible, it should be hypodermically injected.

But is strychnia the antidote to chloral? This was asserted by Liebreich, but is contradicted by Oré, the Professor of Physiology at the Bordeaux School of Medicine ("Lancet," Sept. 21, 1872, p. 427).

The following table represents the various treatments adopted in twenty-four cases of recovery, after taking strychnia.

In 7, Chloroform and emetics.
In 1, Chloroform and electricity.
In 1, Chloroform and tincture of aconite.
In 7, The stomach-pump and emetics only.
In 1, Emetics, Indian hemp, and chloric ether.
In 3, Opium.
In 2, Nicotine.
In 1, Albumen.
In 1, Chloral-hydrate.

Tests for Strychnia.

1. When pure it is white and intensely bitter.
2. It melts and burns with a smoky flame when heated on platinum foil.

3. Sulphuric acid has no action upon it, except that of dissolving it.

4. It is not coloured like morphia by sulphomolybdic and by iodic acids.

5. What is known as the "*colour test*," is by far the most important test for strychnia, and this we must examine in some detail.

When strychnia is brought under the influence of *nascent oxygen,* that is, oxygen at the very moment it is set free, the strychnia instantly acquires a deep rich blue colour, which speedily passes into a purple, then into a violet, then into a crimson, and then into an orange and yellow. The fact that brilliant colours appeared when strychnia was first mixed with oxide of lead, and touched with a drop of sulphuric acid, was noticed by Marchand in 1845. Other reagents have since that time been recommended in the place of the plumbic oxide, *e.g.*, Otto, in 1846, suggested bichromate of potash; Mack, in the same year, peroxide of manganese; Bueger, in 1850, chromic acid; whilst ferricyanide of potassium, the alkaline iodates, and permanganate of potash have been recommended by others. Dr. Letheby was the first to suggest the use of the galvanic battery in performing the colour test. This constitutes an experiment of great value and interest from the fact that it clearly demonstrates the true theory of the production of the colour by avoiding the addition of all chemical reagents. As regards the numerous substances suggested by various authorities, it must be remembered that the simple fact is, that anything that will give out oxygen, will develop the tints.

There is a right and a wrong way of performing the experiment. Proceed as follows:—Place the strychnia on a clean white plate, and touch it with a drop of concentrated sulphuric acid. Mix the acid with the strychnia thoroughly by the aid of a glass rod. Allow this to stand for a few minutes, and note that if the strychnia be pure, the acid will not discolour it. Place by the side of the mixture of the acid with the strychnia a small quantity of either finely powdered peroxide of manganese or lead, and with a glass rod cautiously stir a little of the powder into the mixture, taking care to use only a very small quantity of the oxide. The following succession of colours will be noticed: first, blue, passing into purple, then violet, then red, the mixture finally becoming colourless, or nearly so. With ordinary manipulative skill it is impossible to mistake strychnia for any other substance. It has been stated that salicine, sugar, bile, pyroxanthin, piperine, resinous matters, and many other things act as possible fallacies, but with all these bodies it will be noticed that a change of colour is produced directly they are mixed with the acid, whilst in the case of strychnia no such alteration of colour will be observed.

We strongly recommend either peroxide of manganese, or peroxide of lead, as oxidising agents. The use of permanganate of potash is most unadvisable, inasmuch as the colours produced by the action merely of sulphuric acid on the salt itself, are perilously similar to those produced when strychnia is present.

Potassic bichromate, which is used by many, is assuredly of all bodies the worst for the purpose.

(*a*) It is itself coloured by the acid, and thus complicates results.

(*β*) It will not act when organic and other matters are present, such as *e.g.*, the vegetable acids, tartar emetic, potassio-tartrate of soda, sugar, gum, a trace of morphia, nitre, or common salt.

(γ) It is the least delicate of all the re-agents, even under the most favourable circumstances; for whilst the oxide of manganese or the oxide of lead will show the presence of a 1-20,000th of a grain of strychnia, the bichromate will not act well with less than the 1-2000th of a grain.

There need be no difficulty in the use of either the peroxides of lead or manganese because of their dark colour. A very small quantity is all that is needed, and the colours produced by them are far more permanent and intense than those developed with the bichromate.

It may possibly be urged that if aniline be present it acts as an important fallacy to these colour tests. It is true that the salts of aniline are not coloured when sulphuric acid is added to them, and also that a play of colour does result as soon as nascent oxygen is set free by the addition to the acid mixture of either oxide of lead or manganese, as in the case of strychnia. But no confusion or difficulty can arise if the play of colours be well noted. The following is the tint order with *strychnia;* a very evanescent blue, then purple, then violet, then red, becoming at last colourless. With *aniline*, it is first green, then a very persistent blue, then black.

Dr. Letheby's suggestion that the galvanic battery should be used as a means for developing nascent oxygen removes not only every possible source of fallacy, giving us the power of evolving or stopping the oxygen at pleasure, but also admits of a perfect recognition of tints without the interference of any extraneous colours. Proceed as follows:—Place a drop of a solution of strychnia (say one part in 15,000 or 20,000 of water) in a slight cup-shaped depression on a piece of platinum foil. Allow the fluid to evaporate, and when dry moisten the spot with a little concentrated sulphuric acid. Connect the foil with the positive pole of a single cell of Grove's battery, and touch the acid with a platinum terminal from the negative pole. In an instant the violet colour will flash out, and on removing the pole from the acid, the tint will remain.

6. *Marshall Hall's Test.*

There is no test for strychnia so remarkably delicate and so absolutely certain as its physiological action on a small animal, the frog, being, according to Marshall Hall, the best for the purpose. The solution to be examined should be injected under the skin of the back, the liquid being far less liable to run out of a wound in this part of the body than if it be injected, as is commonly recommended, into the abdominal cavity. Just raise the skin of the back with the forceps, and with a fine pair of scissors make an opening large enough to admit the end of a small pipette. A minute quantity of strychnia injected in this manner will show results that are unmistakeable, even where we fail to get satisfactory evidence by the colour tests. Dr. Harley asserts that on injecting 1-18,000th of a grain into the lungs of a small frog, tetanic convulsions occurred in nine and a half minutes, and death in two hours.

The following may be regarded as the ordinary course of the symptoms in the frog after its hypodermic injection. For a short time the animal remains perfectly quiet. The first symptom noticed will be a difficulty of breathing, which gradually increases until the animal seems to be gasping for its life. A slight tremor, especially in the hind legs, but more or less over the entire body, will be observed. Sometimes the frog will at this stage remain quiet, whilst at other times it will give several energetic and convulsive leaps. The characteristic tetanic convulsions will now make their appearance. Occasionally at their commencement, the animal will make a strange shriek, as if in pain, at the same time turning over from side to side. The spasms are not continuous, but may instantly be produced by touching the frog, or by clapping the hands, or by knocking the table with the finger. According to Dr. Harley, "emprosthotonos" is more common in the frog than opisthotonos, the reverse being the case in man. It will be remarked, that the pupils dilate during the fits and contract in the intervals.

7. *Iodine.*

The following is the best plan of making the experiment with iodine:—

Place on a microscope glass a very small drop of an alcoholic solution of iodine, and allow it to evaporate, and *directly* it is dry add a drop of the strychnia solution, acidulated with acetic acid, to which has been added a trace of sulphuric acid and a drop of spirits of wine. (To see these reactions, a solution of a trace of strychnia in three drams of acetic acid, one dram of spirits of wine, and six drops of dilute sulphuric acid gives good results.)

After it has dried spontaneously, it is to be examined under the microscope with a Nicol's prism and selenite, using no analyser, and merely a common eye-piece. The following characteristic figures will be seen :—

(*a*) Small tufts, mostly circular, of acicular black crystals, as fine as needles.

(*b*) Myriads of minute dots of a somewhat triangular form, some being larger than others, and well-defined. They are generally coloured yellow, pink, and green.

(*c*) Large triangular crystals generally of a yellow or green colour, and composed of three parts radiating from a centre.

(*d*) A number of solid macled prisms, presenting here and there complementary tints of red and green.

(*e*) Solid rosette macles of four, five, and six sided prisms. These, however, are not so abundant unless the strychnia is added to the iodine solution.

(*f*) Lastly, when the strychnia is in any considerable quantity, large feathery and tabular plates of a colourless salt of strychnia not combined with iodine will be apparent.

There are other ways in which the experiment may be made. The forms described are sometimes well displayed by dropping a mere fraction of a grain of strychnia on an alcoholic solution of iodine to which a trace of acetic acid has been added. There is another method by which we have obtained very good results; namely, by touching a glass slide first with a drop of acetic acid, and afterwards with a solution of iodine, just so as to colour the acid slightly yellow, when upon adding to this the mere trace of dry strychnia, a deep red brown colour instantly appears, which in a few minutes changes to orange yellow. Place over this a covering glass, and on examining it with a microscope in the manner described, either one or other or all of the several varieties of crystals already noted will be observed. If the acetic acid is added afterwards, myriads of minute acicular and somewhat macled crystals are generally developed. It is preferable, however, that the acetic acid should be added first, as better results are in this way obtained. There is no difficulty by this means of detecting the 1-2500th of a grain.

8. *Iodide of Potassium.*

Produces an amber-coloured precipitate.

Add to the strychnia a drop of acetic acid upon a glass slide, and touch it with a drop of an aqueous solution of iodide of potassium. The crystals appear under the microscope as macles and prisms grouped in rosettes. They are insoluble either in excess of the iodide or in free alkalies, but are soluble in most acids.

9. *Carbazotic Acid.*

Gives a pale yellow precipitate, sparingly soluble even in a large excess of acetic acid. The precipitate appears under the microscope in the form either of minute needles arranged in tufts, or as feathery crystals serrated at the edges.

Strychnia is also precipitated by the *chlorides of gold* and *of platinum* (pale yellow); by *perchloride of mercury* (white, soluble in acetic acid; crystals being plumose tufts); by *perchloride of iron* (yellow; crystals octahedra); by *tannic acid* (white); by *ferrocyanide of potassium* (yellow; radiating acicular crystals, soluble in most acids); by *sulphocyanide of potassium* (white and crystalline, in radiating tufts, sparingly soluble in dilute acetic and hydrochloric acids); by *potash and soda and by their carbonates, and by ammonia* (white, consisting of the pure alkaloid, soluble in all dilute acids); and by *bichromate of potash* (bright yellow octahedral crystals, soluble in nitric acid, insoluble in acetic acid).

Toxicological Analysis.

In conducting a toxicological examination either of the contents of the stomach, or of any organic mixture for strychnia, proceed as follows:—

(A). Acidify the organic mixture with a little acetic acid, diluting it with sufficient water to make it filter easily. Acetic acid is preferable to other acids, because (1) acetate of strychnia is a very soluble salt. (2) The acid coagulates casein and other albuminous matters. (3) An excess is easily got rid of. (4) It does not change starchy matters into sugar. And (5), it cannot complicate the enquiry if other poisons have afterwards to be sought for.

Filter the acid aqueous solution through muslin, and evaporate the filtrate on a water bath to the consistence of a thick syrup. Treat this residue with eight or ten times its bulk of alcohol; filter and distil off the alcohol. The extract, if strychnia be present, will be intensely bitter. If necessary, dilute the residue with water, and again filter. Supersaturate the filtrate with liquor potassæ, and shake the solution up with its own bulk of ether. Allow the mixture to stand until the ethereal solution has separated. Decant the ether, and treat the watery liquid two or three times in a similar manner with ether. Chloroform is no doubt a better solvent for strychnia than ether, but it is very much more difficult to manage. Distil off the ether and dissolve the residue out of the flask with a little dilute acetic acid. If the solution be turbid, filter, in order to get rid of fatty matters. By a second treatment with potash and ether, the alkaloid will probably be obtained in a state pure enough to be tested. But if not, or should it contain piperine (which would interfere with the colour test), treat the residue with a few drops of concentrated sulphuric acid, and stand it in a warm place for a few hours. The acid will not injure the strychnia, but it will char the organic matter. Afterwards dilute with water, saturate with potash, and treat again with ether, when the alkaloid will be obtained in a pure state. To this residue apply the colour and other tests already described.

(B). The method adopted by Messrs. Rodgers and Girdwood, is somewhat similar.

The contents of the stomach and the stomach itself, cut into small pieces, is to be digested in water acidulated with hydrochloric acid over a water bath for two hours, then strained through muslin, filtered and evaporated to dryness over a water bath. The residue is to be digested in alcohol acidulated with hydrochloric acid, filtered and again evaporated to dryness. Again treat with distilled water, and filter into a long wide tube. To this first add excess of ammonia, and afterwards shake up with half an ounce of chloroform. The chloroform having subsided, draw it off with a pipette, and evaporate it to dryness in a small evaporating basin; afterwards moisten the residue with concentrated sulphuric acid, and allow the mixture to remain on a water bath for half an hour. Add to this some distilled water, pouring the solution into a test tube, and thoroughly rinsing out the basin with hot distilled water. When cold, add ammonia in excess, and shake the solution up with three drams of chloroform. It may be necessary to repeat the charring with the sulphuric acid. Evaporate a few drops of the chloroform solution on a white porcelain dish, and test with sulphuric acid and peroxide of manganese in the manner already described.

If the particles of chloroform do not readily aggregate, the tube must be placed for a few minutes in hot water, and if this does not succeed, the mixture should then be diluted with a large bulk of water.

(C). When the liver, spleen, kidneys, or other tissues are the subject of analysis, they should first of all be reduced to a pulp by rubbing them well up in a mortar, and afterwards digested for several hours with acidulated water. The solution should then be boiled, and when cold strained through muslin and evaporated over a water bath, the same process being then adopted as with the contents of the stomach.

(D). To obtain strychnia from *urine*, set it aside for a few days, until it decomposes and becomes alkaline; filter, shake up with chloroform, and purify the alkaloid as already described.

(E). If *blood* is being examined, dilute it with an equal bulk of water, acidulate with acetic acid, and boil for a short time. Filter and evaporate the filtrate nearly to dryness. Treat the residue with alcohol, and proceed as before.

(F). Strychnia may, according to Mr. Rodgers, be detected in the bones of animals poisoned with it. The following is the process recommended by him for its detection in these more solid parts of the human body.

"The bones, broken into pieces of a convenient size, are placed in a deep evaporating basin, and covered with dilute hydrochloric acid (one part acid and ten parts water), and digested over a water bath until dissolved. When cold the liquid is filtered. To the filtered liquid sulphuric acid must be added so long as a precipitate is produced when the liquid is to be again filtered. To the filtrate sulphate of magnesia must be added in the proportion of one ounce to every pound of bones used. Excess of ammonia is now added and the liquid again filtered. This liquid must now be agitated with about half an ounce of chloroform in a stoppered bottle, which, as before stated, dissolves the strychnia. After subsidence, the chloroform is to be drawn off by a pipette and agitated in a capacious tube with distilled water. The chloroform must again be drawn off, and evaporated to dryness over a water bath; the residue, after being moistened with concentrated sulphuric acid, is to be again heated over a water bath for half an hour, then diluted with distilled water, and filtered into a tube. Excess of ammonia is now to be added, and the liquid again agitated with about three drams of chloroform. This last operation requires repetition, as the chloroform solution will not at first yield, on evaporation, the strychnia in a sufficient state of purity for the application of the colour test. It may be necessary to remark that in the above process advantage is taken of the solubility of strychnia, for as the ammoniacal solution to which the chloroform is first added will generally equal an imperial pint in quantity, nearly one grain and a quarter of strychnine might be in solution, notwithstanding the presence of excess of ammonia."

(G). Dialysis may also be adopted for the separation of the poison from the organic mixture. Acidulate with either acetic or hydrochloric acids, put the mixture into the dialyser and float in a dish containing distilled water. After allowing it to remain for two days, evaporate the diffusate to dryness and test the residue. The results obtained by the authors by this method are not satisfactory.

(H). Or, lastly, the general process suggested at the commencement of this chapter may be adopted.

Failure in Detecting Strychnia after Death.

The question respecting the causes of failure in detecting strychnia after poisoning is an important one. There are some who assert that when strychnia has been given in a minimum dose to cause death, it is not possible for the chemist to detect it, owing to its decomposition in the living organism; whilst others say that there are no cases in which strychnia may not be detected in the animal body after the administration of a fatal dose, no matter how the poison was given or how long after death the analysis was made.

Both these statements require modification. The first we believe to be untrue, and the second a little too strongly stated. Failures in detecting the poison, it must be admitted, have too often been due to miserably imperfect methods of research, and the employment of rough processes that modern chemistry will not sanction. Strychnia, it is certain, does not decompose in the presence of organic matter. At the time of Palmer's trial in 1856, Dr. Letheby put 0·5 grains of strychnia into a bottle with a dog's stomach, and sealed it up. In 1869 (thirteen years afterwards), one-half of this was examined by one of the authors and all the strychnia reactions obtained. The remainder is still preserved. But if the dose has been a minimum one, and the period between the taking the poison and death considerable, it is just probable that complete elimination of the poison may take place, and render its discovery impossible. Such cases are certainly very rare, but still it would be wrong to lose sight of their possibility.

The answer then to the question, Under what circumstances may strychnia fail to be detected after death? is this: If the dose that caused death was very small, and a considerable time elapsed between its administration and death, complete elimination of the poison from the system is possible. Or, in other words, failure to detect the poison is not due to its *decomposition* in the presence of tissue either living or dead (for it is not decomposed), but to its *elimination.* But if death is rapid (as it usually is), the length of time that elapses between death and the analysis is perfectly immaterial; for to use Mr. Rodgers's words, "Putrefaction, so far from interfering with the separation of the strychnia, greatly facilitates it." If then strychnia causes death, only provided that the dose is not absolutely a minimum one, and that sufficient time has not elapsed for its entire elimination, it is in the body, and the toxicologist should find it, no matter whether the examination is made immediately after death, or whether years have elapsed between the fatal result and the analysis.

Cases of Poisoning with Strychnia.

(I.) STRYCHNIA.

1.

"Medical Times and Gazette," July, 1856 (Dr. Booth). Male: æt. 46. 1½ grain; repeated small doses having been taken previously.

	Symptoms. — Stupor; loss of speech; opisthotonos; pupils dilated.		*Result.* – Death in 2½ hours.	*Post-mortem and analysis.* —Membranes of brain and spinal cord congested; apoplectic clot in right corpus striatum.

2.

"Lancet," Jan. 7, 1838, p. 647 (Dr. Blumhardt). Male: æt. 17. 40 grains.

Time of symptoms commencing. — Almost directly.	*Symptoms.* — Complete stiffness of head and body in 15 minutes; perfect consciousness; pupils dilated; tetanus.	*Treatment.*— 4 grs. of tartar emetic, which produced very little vomiting.	*Result.* — Death in 1½ hour.	*Post-mortem and analysis.* —Body very stiff; two pounds of fluid but tarry blood ran out when the spinal cord was opened; no strychnia found!! stomach normal.

3.

"Lancet," Aug. 31, 1850 (Mr. George Bennett). Female: æt. 13. 1½ grain in solution.

Time of symptoms commencing. — In 1 hour.	*Symptoms.* — Twitchings first appeared; opisthotonos; violent tetanic fits; pupils dilated during fits; afterwards contracted.	*Treatment.*— Emetics and vinegar and water.	*Result.*— Death in 2½ hours.	

4.

Wormley, on Poisons, p. 542; "Edinburgh Monthly Journal," Dec., 1845, p. 908. (Dr. Watson). Female: æt. 12. ¾ of a grain.

Time of symptoms commencing. — In 20 minutes.	*Symptoms.* — Opisthotonos.		*Result.*— Death in 1 hour.	*Post-mortem and analysis.* —Brain and membranes natural; spinal cord healthy; cavities of heart empty; stomach natural; face placid; lungs much congested.

5.

"Medical Gazette," vol. xxxvii., 1846, p. 925. Male: æt. 26. Dose (?).

Time of symptoms commencing. — (?.)	*Symptoms.*—(?.)		*Result.*— Found dead.	*Post-mortem and analysis.* — Brain and membranes healthy; lungs gorged; heart contained coagulated blood.

6.

"Medical Gazette," vol. xxxvii., p. 254. Female: æt. 35. 3 grains taken in tea.

Time of symptoms commencing. — In 20 minutes.	*Symptoms.* — Convulsions very violent, with periods of intermission.		*Result.*— Death in 1¾ hour.	

7.

Casper's "Wochenschrift," Feb. 28, 1846; "American Journal of Medical Science," Jan., 1848. Male: adult. 30 grains taken in spirit.

Time of symptoms commencing. — In 15 minutes.	*Symptoms.* — Muscular twitchings; afterwards opisthotonos.		*Result.*— Death in 30 minutes.	

8.

"Edinburgh Monthly Journal," April, 1846, p. 230 (Dr. Edwards). Male: adult. Dose (?).

Time of symptoms commencing. — (?.)	*Symptoms.*—(?) pupils dilated.	*Treatment.*—(?.)	*Result.*— Death.	*Post-mortem and analysis.* —Brain and membranes healthy; lungs congested with dark fluid blood; heart distended with dark fluid blood; stomach healthy.

9.

"British American Journal," Aug., 1847 (Case of Dr. Warner). Male: æt. 39. ½ grain of sulphate of strychnia.

Time of symptoms commencing. — In [illegible] minutes.	*Symptoms.* — Constriction of throat was the first symptom; tetanic convulsions; opisthotonos; mind clear to the last.		*Result.*— Death in 20 minutes.	

10.

"Medical Times and Gazette," April 15, 1854, p. 376. Female: æt. 36. ¼ of a grain (?).

Time of symptoms commencing. — In 10 minutes.	*Symptoms.* — Convulsions; emprosthotonos.		*Result.*— Death in 1¾ hour.	

11.

"Pharmaceutical Journal," 1848, vol. ii., p. 298. Female: adult. 3 grains in solution.

Time of symptoms commencing. — In 5 to 10 minutes.	*Symptoms.* — Spasms; perfect consciousness.		*Result.*— Death in 1¼ hour.	*Post-mortem and analysis.* —Heart contracted and empty; blood fluid; nothing remarkable in other parts.

12.

"Medical Times and Gazette," April 28, 1855. Female: æt. 12. 1 grain taken in pill by mistake for valerianate of zinc.

Time of symptoms commencing. — Very soon.	*Symptoms.* — Sickness, and tetanic convulsions.		*Result.*— Death in 1½ hour.	

13.

"Edinburgh Monthly Journal," Sept., 1851, p. 234 (Dr. Smith). Male: adult. Dose (?).

Time of symptoms commencing. — (?.)	*Symptoms.*—(?.)		*Result.*— Death.	*Post-mortem and analysis.* —Every joint rigid; countenance livid; brain and membranes very congested; blood fluid and dark-coloured; stomach somewhat congested; spine not examined.

14.

"Edinburgh Monthly Journal," 1855 (Dr. Lonsdale). Male: æt. 59. 1½ grain taken by mistake for jalapine.

Time of symptoms commencing. — In ½ an hour.	*Symptoms.* — Violent spasms; intervals 4 to 8 minutes; tetanus; pupils dilated.		*Result.*— Death in 1 hour.	*Post-mortem and analysis.* —Brain natural; heart healthy and empty; lungs congested; stomach healthy.

15.

"Medical Times and Gazette," Dec. 16, 1854, p. 624 (Mr. D. G. McPherson). Male: adult. Dose (?).

Time of symptoms commencing. — (?.)	*Symptoms.* — Found with his body arched, teeth clenched, and pupils dilated.		*Result.*— Death.	*Post-mortem and analysis.* —Stomach was congested in spots, and the mucous membrane softened; lungs engorged; red spots about the duodenum.

16.

"Dublin Medical Press," June 25, 1856 (Dr. Geoghegan). Male: æt. 26. 5 grains.

Time of symptoms commencing. — In 15 minutes.			*Result.*— Death in 20 to 25 minutes.	*Post-mortem and analysis.* —Lungs congested; heart contracted, and containing a little dark fluid blood; mucous membrane of stomach softened.

17.

"Lancet," June 8, 1861, p. 571 (Mr. Lawrence). Female: æt. 30. Probably taken in solution. Dose (?).

Time of symptoms commencing. — (?.)	*Symptoms.* — Tetanic spasms.	*Treatment.*—(?.)	*Result.*— Death in about ¾ of an hour.	

18.

"Lancet," Nov. 16, 1861, p. 480 (Mr. Tarleton). Male: æt. 12. 3 grains taken in pill which had been made [illegible] months, and was very hard.

Time of symptoms commencing. — 3 hours.	*Symptoms.* — Usual symptoms; conscious and sensible to the last.	*Treatment.*— Chloroform and stomach pump.	*Result.*— Death in 3 hours and 10 minutes.	

19.

"Ann. d'Hygiène," 1861, vol. i., p. 133. Male: æt. 7½. ¾ of a grain.

			Result.— Death in ½ an hour.	

20.

"Lancet," July 26, 1856, p. 117 (Dr. Martyn). Female: æt. 45. ¼ of a grain.

Time of symptoms commencing. — Shortly.	*Symptoms.*—As usual.		*Result.*— Recovery.	

21. Taylor's "Medical Jurisprudence." Male: adult. ¼ of a grain taken at intervals.				
			Result.—Recovery.	
22. "Lancet," Aug. 17, 1861, p. 169 (Dr. Powell). Female: æt. 28. 2—3 grains as rat poison.				
	Symptoms.—Ordinary symptoms.	*Treatment.*—Chloroform for 3 hrs. then emetics.	*Result.*—Recovery after some weeks.	
23. "Lancet," Jan. 10, 1863, vol. i., p. 54 (Dr. Ansell). Female: æt. 20. 4 grains.				
	Symptoms.—Severe paroxysms; opisthotonos.	*Treatment.*—Only albumen given.	*Result.*—Recovery in 7 hours.	
24. "Medical Gazette," vol. xli., p. 305. 7 grains.				
			Result.—Recovery.	
25. Taylor's "Medical Jurisprudence," vol. i., p. 408 (Case of M. Merghelynk). 7½ grains.				
			Result.—Death in 15 minutes.	
26. Taylor's "Medical Jurisprudence," vol. i., p. 408 (Case of Madame Merghelynk). 7½ grains.				
			Result.—Death in 10 minutes.	
27. "Lancet," May 30, 1857, p. 551 (Mr. Wilkins). Male: æt. 23. 3 grains.				
	Symptoms.—Tetanic convulsions; opisthotonos: feet inverted; consciousness perfect to the end.	*Treatment.*—Emetics.	*Result.*—Death in 6½ hours.	*Post-mortem and analysis.*—Body very rigid; fingers contracted; brain and membranes congested; right side of heart full of dark fluid blood; lungs congested; no poison found.
28. "Medical Times and Gazette," Nov. 1857. Female: æt. 17. ʒj of Butler's vermin-killer.				
			Result.—Death in 1 hour.	
29. "Edinburgh Monthly Journal," 1859, vol. ii., p. 507. Male. Packet of vermin-killer. Quantity=3 grains of strychnia.				
			Result.—Recovery.	
30. Taylor's "Medical Jurisprudence," vol. i., p. 414. Male: æt. 43. 5 grains.				
Time of symptoms commencing.—15 minutes.			*Result.*—Death in 30 minutes.	

31.

"American Journal of Medical Science," Oct., 1864, p. 399. Female. 6 grains.

Time of symptoms commencing. — 3 minutes.			*Result.* — Death in 30 minutes.	

32.

"Wormley on Poisons," p. 538. Male. 5 grains.

Time of symptoms commencing. — 1¾ hour.			*Result.* — Recovery.	

33.

"American Journal of Medical Science," April, 1848, p. 562. Male. 7 grains taken in 2 doses, at 5 hours' interval.

Time of symptoms commencing. — 2½ hours.			*Result.* — Recovery.	

34.

"American Journal of Medical Science," Jan. 1863, p. 259. Male. 8 to 10 grains of Nitrate of Strychnia taken at one time, and afterwards 12 grains.

		Treatment. — Cranberry soup was taken before the poison; the first dose was taken in bitter-almond water, and after the last dose 10 grains of acetate of morphia was swallowed.	*Result.* — Recovery.	

35.

Taylor's "Medical Jurisprudence," vol. i., p. 781. 10 grains.

			Result. — Death in 10 minutes.	

36.

"American Journal of Medical Science," April, 1854, p. 537. Male. 1¾ grain of strychnia, with the same quantity of nux vomica.

			Result. — Death immediate.	

37.

"American Journal of Medical Science," Oct., 1861, p. 409. 6 grains.

			Result. — Death in 6 hours.	

38.

"American Journal of Medical Science," Oct., 1862, p. 562. Female: æt. 26. ⅙ grain.

Time of symptoms commencing. — 10 minutes.			*Result.* — Recovery in [illegible] weeks.	

39.

Pereira's "Materia Medica." Female. 2 to 3 grains.

			Result. — Death in 2 hours.	

40.

"British and Foreign Medico-Chirurgical Review," April, 1857, p. 502. Male. 10 grains.

Time of symptoms commencing. — 15 minutes.	*Symptoms.* — Vomiting occurred very early. Symptoms as usual.		*Result.* — Recovery in 1 week.	

41.

"Lancet," May 17, 1873, p. 698 (Dr. Dickinson). Female: æt. 16. Gibson's vermin-killer.

Time of symptoms commencing. — A few minutes.		*Treatment.* — Hypodermic injection of ʒiss of chloral hydrate.	*Result.* — Recovery.	

42.

"Lancet," Oct. 11, 1873, p. 533. Male: æt. 37. About 1 grain.

Time of symptoms commencing. — 5 minutes.			*Result.* — Death in 1 hour.	

43.

"Lancet," Jan. 13, 1872, p. 43. Male: adult (rat poison). = 1 grain of strychnia.

Time of symptoms commencing. — 20 minutes.	*Symptoms.* — Treatment adopted before the symptoms set in.	*Treatment.* — ℥ss tinct. opii.	*Result.* — Recovery.	

44.

"Lancet," Dec. 23, 1871, p. 907 (Mr. Beatty). Female: æt. 22. Packet of Battle's vermin-killer, then ʒij of laudanum, and then ʒss of red precipitate.

Time of symptoms commencing. — 30 minutes.	*Symptoms.* — None of the ordinary strychnia symptoms occurred; those of opium poisoning set in after 30 minutes.		*Result.* — Recovery.	

45.

"Lancet," Dec. 23, 1871, p. 907 (Mr. Beatty). Female: æt. 17—pregnant. Battle's vermin-killer.

Time of symptoms commencing. — Very soon.	*Symptoms.* — Opisthotonos.	*Treatment.* — Tincture of opium.	*Result.* — Recovery.	

46.

"Medical Times and Gazette," May 25, 1861, p. 561 (Mr. Thornton). Female. 3 or 4 grains.

Time of symptoms commencing. — Very soon.	*Symptoms.* — Violent convulsions occurring every 20 minutes; no pain.	*Treatment.* — Emetics and chloroform.	*Result.* — Recovery.	

47.

"Lancet," July 10, 1852, p. 33 (Dr. Cooper Forster). Male: æt. 52. About 1 grain.

Time of symptoms commencing. — In 10 minutes.	*Symptoms.* — Tetanic convulsions; opisthotonos; a paroxysm every [illegible] minutes, lasting 2 minutes.	*Treatment.* — Emetics.	*Result.* — Recovery.	

48.

"Lancet," June 9, 1855, p. 596 (Mr. Hendry). Male: æt. 30. ʒij of Butler's vermin-killer.

	Symptoms. — Tetanic convulsions; opisthotonos.	*Treatment.* — Emetics and stomach pump, but these were not used for 1½ hour.	*Result.* — Recovery.	

49.

"Lancet," April 19, 1856, p. 428 (Dr. Ogston). Male: æt. 28. A packet of Marsden's vermin and insect killer = ¾ of a grain of strychnia.

Time of symptoms commencing. Almost immediate.		*Treatment.* — No treatment.	*Result.*— Death.	*Post-mortem and analysis.* —Pupils dilated; back part of scalp loaded with blood; brain and membranes natural; a quantity of blood in the spinal canal; blood on both sides of heart; lungs much congested; stomach and duodenum congested; strychnia discovered.

50.

Case of Dove, *vide* "Lancet," March 15 and 22, 1856, pp. 292—321.

51.

"Lancet," Sept. 13, 1856, p. 302 (Dr. Jones, Jersey). Female: æt. 22. ½ a grain.

Time of symptoms commencing. — In 20 minutes.	*Symptoms.* — Tetanic convulsions, which at one time left, but returned; opisthotonos.	*Treatment.* — Scarcely any.	*Result.*— Death in 5 hours.	*Post-mortem and analysis.* —Spine arched; fingers and jaw firmly clenched; much blood escaped on opening the skull and spinal cord; stomach natural; each ventricle of heart contained a clot of dark semi-fluid blood.

52.

"Lancet," July 26, 1856, p. 107 (Mr. Craster). Female. ¼ of a grain in 3 pills, with half-an-hour's interval between each.

Time of symptoms commencing. — Began after taking 2nd pill.	*Symptoms.* — Violent convulsions; tetanus.	*Treatment.*— Emetics.	*Result.*— Recovery in 5 hours.	

53.

"Lancet," Oct. 10, 1857, p. 361 (Mr. Hazell). Female. Over 3 grains.

			Result.— Death.	*Post-mortem and analysis.* —Post-mortem in 58 hours; fingers and jaws fixed; lungs congested; heart large, full of blood; on the right side stomach natural; brain congested at the base.

54.

"Lancet," July 13, 1867, pp. 41 and 118 (Mr. Folker). Male: adult. 3 grains of vermin-killer.

Time of symptoms commencing. — In ¾ of an hour.	*Symptoms.*—Only 2 minutes' interval between spasms; great thirst; spasms ceased in 12 hours; Intellect clear.	*Treatment.* — Kept under the influence of chloroform. Tincture of aconite given.	*Result.*— Recovery.	

55.

"Lancet," Jan. 17, 1846, p. 73 (Dr. Watson). Female: æt. 13. ¾ of a grain in 3 pills.

Time of symptoms commencing. — In 20 minutes.	*Symptoms.* — Opisthotonos; mind clear; convulsions ceased suddenly; pupils dilated.	*Treatment.* — Emetics; bleeding; stomach pump; galvanism.	*Result.* — Death in about 1 hour.	*Post-mortem and analysis.* —Post-mortem in 44 hours. Brain and membranes natural; spinal cord healthy, but the membranes congested; lungs congested; stomach normal.

56.

"Transactions of Pennsylvania Medical Society;" "Berlin Journal," Dec. 15, 1870 (Dr. Gobrecht). Male: æt. 20. ℥i of chloroform and 15 grains of strychnia.

	Symptoms. — Profoundly comatose, but no strychnia symptoms.	*Treatment.* — Electricity.	*Result.* — Recovery.	

57.

"Medical Times and Gazette," March 11, 1871, p. 283 (Dr. Atlee). Male: æt. 60. 20 grains in solution taken on a full stomach.

	Symptoms. —Violent tetanus.	*Treatment.* — Chloroform and emetics.	*Result.* — Recovery.	

58.

"Medical Times and Gazette," Oct. 23, 1869, p. 491 (Dr. Cameron). Female: æt. 17. A 3*d.* packet of Butler's vermin-killer = ¾ of a grain of strychnia.

Time of symptoms commencing. — After 2 hours.	*Symptoms.* — Violent spasms.	*Treatment.* — Stomach pump; chloroform.	*Result.* —Recovery.	

59.

"Medical Times and Gazette," May 9, 1868, p. 499 (Mr. McCarthy). Female: æt. 4. Powder for destroying mice.

Time of symptoms commencing. — Very soon.	*Symptoms.* — Opisthotonos; pupils dilated.	*Treatment.* — Chloroform administered for 1½ hrs.	*Result.* — Recovery.	

60.

"Medical Times and Gazette," June 27, 1868, p. 691 (Mr. Phelps). Female: æt. 14. Pennyworth of strychnia in a bottle of ginger-beer = about 1 grain.

Time of symptoms commencing. — Very soon.	*Symptoms.* — Opisthotonos.	*Treatment.* — Chloroform; whilst under its influence, the stomach pump was used.	*Result.* — Recovery.	

61.

"Medical Times and Gazette," July 6, 1867, p. 5 (Dr. Hunter). Female: æt. 70. 94 drops of liquor strychniæ taken during 42 hours = ¾ of a grain.

Time of symptoms commencing. — In 5 minutes after the last dose (=⅙ grain).	*Symptoms.* —No opisthotonos occurred, but violent convulsive twitchings; mind clear.		*Result.* — Death.	

62.

" Medical Times and Gazette," March 8, 1862, p. 250 (Dr. Wilmot). Female : æt 18. A packet of vermin-killer.

Time of symptoms commencing. — About 15 minutes.			*Result.*— Death in 35 minutes.	*Post-mortem and analysis.* —Blood dark and fluid; right side of heart full of blood; stomach natural; blue colour of the vermin-killer not apparent, explained by her having previously eaten oranges.

63.

" British Medical Journal," June 22, 1872, p. 660 (Rev. S. Haughton, M.D.). Male: æt. 19. Strychnia put into an egg.

Time of symptoms commencing. — (?.)	*Symptoms.* — Convulsions and opisthotonos.	*Treatment.* — One drop doses of nicotine given every half-an-hour in whisky punch.	*Result.*—Recovery.	

64.

" British Medical Journal," Sept. 18, 1869, p. 322 (Mr. Heward). Female : æt. 56. Packet of Battle's vermin-killer = about 8 grains of strychnia.

	Symptoms.—No vomiting.		*Result.*— Death in 20 minutes.	*Post-mortem and analysis.* —Signs of tetanic convulsions; stomach congested and corrugated; bladder empty, and hard; heart contracted and empty.

65.

"New York Medical Record," March 1, 1867. 4 grains.

	Symptoms.—Vomiting.	*Treatment.*— Kept under chloroform for 7 hours.	*Result.*— Recovery.	

66.

" British Medical Journal," Sept. 21, 1867, p. 250 (Dr. Henry Thompson). Female : æt. 49. One of Battle's 6*d.* packets of vermin-killer.

Time of symptoms commencing. — Immediate hot burning taste, and twitchings.	*Symptoms.*—Insensible in ½ an hour; and remained so for 6 or 8 hours.	*Treatment.* — Conium and camphor were administered.	*Result.*—Recovery in 1 month.	

67.

" British Medical Journal," Dec. 30, 1871, p. 754 (Dr. Roberts). Vermin-killer.

			Result.— Found dead.	*Post-mortem and analysis.* —Expression of face calm, and not distorted, and the bedclothes were found tucked in.

68.

" British Medical Journal," May 20, 1865, p. 509 (Mr. Rogers). Female : æt. 25. Barber's magic vermin-killer powders (2·8 grs. strychnia in 28 grains of powder).

	Symptoms. — Ordinary symptoms.	*Treatment.* — Stomach pump.	*Result.*— Death in 2 hours.	*Post-mortem and analysis.* —Rigidity of muscles found to have disappeared after 9 hours; brain and spinal cord healthy; lungs very congested; both sides of heart empty; blood very fluid.

69.

"Edinburgh Medical Journal," April, 1875, p. 907 (Dr. Ogilvie Will). Male: æt. 18. Not less than 4 grains of strychnia.

Time of symptoms commencing. — A few minutes.	*Symptoms.*—As usual.	*Treatment.*— Chloral hydrate and emetics given.	*Result.*—Recovery.	

70.

"Edinburgh Medical Journal," Sept., 1873 (Mr. Buckley). Male.

		Treatment.— Chloroform and $1\frac{1}{8}$ grain of atropine injected.	*Result.*—Recovery.	

71.

"Medical Times and Gazette," July 20, 1861, p. 67 (Dr. Schuler). Male: æt. 50. $\frac{1}{12}$ of a grain applied to Punctum lachrymale.

Time of symptoms commencing. — 3 minutes.	*Symptoms.* — Tetanus; urine and fæces evacuated.		*Result.*—Recovery	

72.

"Medical Times and Gazette," Dec. 15, 1860, p. 596 (Dr. Part). Female: æt. 31. A 3*d.* paper of Battle's vermin-killer = about 3 grains.

Time of symptoms commencing. — (?.)	*Symptoms.* — Opisthotonos; violent tetanic convulsions.	*Treatment.*— Emetics and afterwards Indian hemp and chloric ether.	*Result.*—Recovery.	

73.

"Medical Times and Gazette," Oct. 30, 1858, p. 443 (Dr. Ogilvie). Male: æt. 21. 4 grains of strychnia, taken probably in coffee.

Time of symptoms commencing. — 1 hour.	*Symptoms.* — Tetanic seizures.	*Treatment.* — Bleeding and emetics.	*Result.*— Death in 70 minutes.	*Post-mortem and analysis.* —Venous congestion of the brain; heart large and empty; lungs very congested; stomach and intestines normal.

74.

"Medical Times and Gazette," Jan. 2, 1855, p. 19, from "Boston Journal." Male: æt. 15. 2 grains of strychnia in powder.

Time of symptoms commencing. — (?.)	*Symptoms.* — Violent symptoms.	*Treatment.*— Chloroform administered for $4\frac{1}{2}$ hours.	*Result.*—Recovery.	

75.

"Medical Times and Gazette," June 12, 1858, p. 600 (Dr. O'Reilly). Male. 6 grains taken in beer.

	Symptoms. — Violent tetanic symptoms.	*Treatment.* — Nicotine given in the form of infusion of tobacco (ʒx of dried tobacco leaves).	*Result.*—Recovery.	

76.

"Medical Times and Gazette," June 14, 1856, p. 609 (Dr. Kirk). Male. 6 grains.

		Treatment. — Stomach pump; friction over spine with hot turpentine.	*Result.*—Recovery.	

(II.) NUX VOMICA.

77.

"Ann. d'Hygiène," 1861, vol. ii. p. 431. Male. 300 grains (powder).

Time of symptoms commencing. — 2 hours.	*Symptoms.* — Convulsions.		*Result.* — Death.	

78.

Christison, p. 901. Female: aged. 3 grains of extract.

			Result. — Death in 3 days.	

79.

"Christison," p. 901. 30 grains (powder).

			Result. — Death.	

80.

"Lancet," Dec. 15, 1849 (Mr. Iliff). Female: æt. 23. ʒij (powder).

Time of symptoms commencing. — Very shortly.	*Symptoms.* — Dilated pupils; tetanic convulsions every 2 minutes.	*Treatment.* — Emetics and stomach pump.	*Result.* — Recovery.	

81.

"London Medical Repository," vol. xix., p. 448, and Wormley, p. 530. Female. ʒiij (powder).

Time of symptoms commencing. — 40 minutes.			*Result.* — Death in 1 hour.	

82.

"New York Medical Journal," vol. xxx., p. 448; and Wormley, p. 531. Female. A tablespoonful (powder).

Time of symptoms commencing. — Instantly.			*Result.* — Recovery in 8 hours.	

83.

Orfila, "Toxicologie," vol. ii., p. 605. Male. Quantity (?).

Time of symptoms commencing. — Immediate.			*Result.* — Death on 4th day.	

84.

"Lancet," Dec. 28, 1839, p. 500 (Dr. R. D. Thomson). Female: æt. 18. Quantity (?).

Time of symptoms commencing. — Very soon.			*Result.* — Death in 2 hours.	

85.

"Lancet," Oct. 22, 1853, p. 385 (Dr. Hassall). Male: æt. 20. ℥iss (powder).

Time of symptoms commencing. — Within 10 minutes.	*Symptoms.* — In ¾ of an hour had tetanic convulsions; opisthotonos.	*Treatment.* — Emetics and stomach pump.	*Result.* — Recovery in 2 days.	

86.

"Lancet," May 17, 1856, p. 551. Female: æt. 18. ʒss (powder).

Time of symptoms commencing. — Very soon.	*Symptoms.* — Tetanus, and previously, complete paralysis of lower extremities; intellect clear.	*Treatment.*— Emetics.	*Result.*— Death in 7 hours.	*Post-mortem and analysis.* —Stomach and gullet much inflamed.

87.

"Lancet," May 17, 1856, p. 551. Female. Nux vomica and strychnia.

Time of symptoms commencing. — In ¼ of an hour.			*Result.*— Death in 1½ hour.	

88.

"Medical Times and Gazette," Jan. 16, 1858, p. 69 (Mr. Ley). (1) Male: adult; (2) Female: adult. 5 grains of extract taken by each in a pill.

Time of symptoms commencing. — 40 minutes.	*Symptoms.* — Violent spasms and tetanus; complained of being "fixed" to the chairs; intellects of both were clear.	*Treatment.*— Emetics.	*Result.*—Recovery.	

89.

"Medical Times and Gazette," Feb. 9, 1856, p. 148 (Mr. Davies). Female: æt. 16. ʒss (powder).

Time of symptoms commencing — Walked two miles after taking it. Symptoms commenced in 1½ hour.	*Symptoms.* — Violent tetanic symptoms.	*Treatment.* — Tannin; sulphate of copper; cold effusion.	*Result.*— Death in 3½ hours.	*Post-mortem and analysis.* —Brain soft and congested; heart almost empty; lungs congested — stomach slightly congested towards pyloric end.

See also the following additional Cases of Strychnia Poisoning:

"Medical Times and Gazette," Dec. 31, 1864. p. 702 (case of Demine poisoning his patient Trümpy.)
" " Aug. 14, 1858, p. 179 (Butler's vermin-killer. Death).
" " March 15, 1856, pp. 274 and 285 (case of Dove).
"British Medical Journal," May 31, 1862, p. 573 (Death from strychnia applied to Puncta Lachrymalia).
"Medical Times," Aug. 21, 1847, p. 512 (¼ to ½ a grain. Death in 14 to 20 minutes).
"British Medical Journal," Jan. 6, 1866, p. 29 (poisoning by Hunter's infallible vermin-killer).

UPAS TIEUTÉ.

"Medical Times and Gazette," Aug. 23, 1862, p. 203 (case at Java). Strychnia symptoms.
" " May 16, 1863, p. 511.

Brucia ($C_{23} H_{26} N_2 O_4$).

Brucia was discovered by Pelletier and Caventou, in 1819, in the seed and bark of the Nux Vomica and S. Ignatius's bean, in conjunction with strychnia.

Brucia is found either as a bitter white odourless and amorphous powder, or in the form of crystals consisting of groups of needles or four-sided prisms, containing 15·45 per cent. of water of crystallization. Brucia has distinctly basic properties, but they are not so powerful as those of strychnia. It melts at 115° Cent., and sublimes at 204° Cent. It is not acted upon by cold sulphuric acid or by caustic alkalies. It is dissolved, but not decomposed by hydrochloric acid. An intense red colour is produced when it is treated with nitric acid, a reaction which does not occur with strychnia. One part of anhydrous brucia dissolves in 1,050 of water at 16° Cent., and in 440 of ether. It is very soluble in benzole, chloroform, and alcohol.

Symptoms, &c.

Brucia has similar properties to those of strychnia, producing almost identical physiological effects, but its activity is very much less. The 1-1000th of a grain of strychnia will produce convulsions in a frog in seven minutes, when given by the mouth. It requires the 1-100th of a grain of brucia to produce the same effect in the same time; that is, strychnia is, as nearly as possible, ten times more powerful in its action than brucia. The convulsions produced are neither so severe nor so long continued. Three cases of death from it are related by Casper and two by Christison.

Tests.

Nitric Acid with brucia and its salts produces a brilliant red colour, which, on the application of a moderate heat, changes to yellow. If, after warming, a trace of protochloride of tin be added, the colour changes to a deep purple, which may be bleached by an excess of either the tin salt or nitric acid. No action is produced with the nascent oxygen colour tests, but if brucia is mixed with sulphuric acid and bichromate of potash added, there is first an orange, then a green, then a yellow tint produced, the action not being dependent on the nascent oxygen as it is with strychnia, but on the reduction of the chromium salts.

The *caustic alkalies* give a white amorphous precipitate, soluble in free acids; *sulphocyanide of potassium*, a white precipitate, first amorphous, then crystalline, insoluble in acetic acid; *bichromate of potash*, a yellow crystalline precipitate, insoluble in acetic, but soluble in nitric acid; *bichloride of platinum*, a yellow precipitate, decomposed by caustic alkalies; *chloride of gold*, a flesh coloured amorphous precipitate; *carbazotic acid*, a yellow precipitate, sparingly soluble in acetic acid; *ferricyanide of potassium*, a light yellow crystalline precipitate, the formation of which is prevented by the presence of a free acid; *iodine in iodide of potassium*, an orange brown amorphous precipitate; *bromine in hydrobromic acid*, a deep brown amorphous precipitate; *perchloride of mercury*, a white amorphous precipitate; *iodide of potassium*, a crystalline precipitate, which takes some time to form; and, *tannic acid*, a white amorphous precipitate.

In an organic mixture, the same process that is described for the recovery of strychnia may be adopted. In testing the residue, the action of nitric acid should be first tried, and afterwards, the protochloride of tin, and if no result is shown with these, it will be useless trying the other tests.

24. MELANTHACEÆ.

Asagræa Officinalis.

(Sabadilla Cevadilla).

The fruit, which is about a quarter of an inch in length, contains one to three seeds, which are of a brown colour, and have a disagreeably persistent bitter acrid taste, and produce when chewed great numbness of the tongue and lips.

Half a dram will prove fatal to a dog or cat, irritant symptoms conjoined with nervous symptoms being produced.

Its poisonous action is due to Veratria, which alkaloid is usually prepared from this plant.

Veratria ($C_{32} H_{52} N_2 O_8$).

(Veratrine.)

Veratria is an alkaloid contained in several plants, such as the veratrum album, probably in the V. Viride, and in Sabadilla, from which it is usually prepared. It exists in these probably as a gallate. One pound of sabadilla yields twenty grains of veratria (Dr. Thomson), and according to Mr. Scattergood, thirty grains may be obtained from one pound of the root of the V. Veride.

It is usually met with as a white amorphous powder, but may be obtained in crystals from the alcoholic solution, although with some difficulty. It has no smell, but if applied to the nostrils, it produces violent and uncontrollable sneezing. It is slightly bitter and acrid to the taste, producing great dryness and heat in the fauces. An intense pricking sensation is produced when the alcoholic solution is applied to the skin.

It is very slightly soluble in water (1 in 9000), somewhat soluble in ether (1 in 100), and very soluble in alcohol chloroform, benzol, and dilute acids.

It melts at 115·C. (239 F.), giving off a pungent vapour, and leaving behind a carbonaceous mass.

The solution has an alkaline reaction. It forms salts with acids, which are very soluble in water and chloroform, but insoluble in ether.

The reactions of acids upon the alkaloid must be specially noted, as they are characteristic.

1. *Sulphuric acid* turns it yellow. The mixture *slowly* becomes crimson, and afterwards violet. The reaction is hastened by heat.
2. *Nitric acid* changes it a light red, becoming yellow.
3. *Hydrochloric acid* (Trapp's Test) dissolves it without changing its colour, but on warming the solution it becomes red.
4. *Chloride of gold* gives a lemon-yellow precipitate.

Action of Alkaloids with Cold Sulphuric Acid, and Alterations produced by the Application of Heat.

	Cold Acid.	When Warmed.
Narceine.	Immediate brown, changing first to brownish yellow, and afterwards to greenish yellow.	Bright brownish red, which darkens, and becomes purple red.
Solanine.	Immediate orange brown, after some hours becoming purple brown.	Darkens, and becomes almost black.
Piperine.	Immediate orange red, becoming brown.	Dark brown.
Salicine.	Immediate crimson pink.	Darkens, and becomes black.
Papaverine.	Immediate purple, the colour soon fading.	Colour discharged.
Veratria.	Slowly changes to a reddish yellow, and after some minutes becomes a crimson red, then violet.	Colour manifests itself immediately, and remains unchanged for hours.

As regards the action of sulphuric acid, it is well to note, that when added to veratria, the red colour is slow in appearing, whilst with the other bodies it is rapid. The preceding table, taken in chief from Wormley, will illustrate the reactions of oil of vitriol, cold and warm, with the several bodies mentioned.

Experiments on Animals.

Experiments on animals prove veratria to be an active poison.

Dose.	Animal.	How administered.	Symptoms.	Death.	Authority.
Gr. ij.	Cat.	Mouth.	Instantaneous frothing at mouth.	Death in 1 minute.	Wormley.
Gr. ij.	Cat.	Mouth.	Instantaneous frothing at mouth.	Death in 1¾ minute.	Wormley.
Gr. iij.	Dog.	Mouth.	Instant vomiting; involuntary micturition.	Death in 2 hours.	Wormley.
Gr. ij.	Dog.	Mouth.	No effect. (This was a different sample of the drug to that used in the preceding experiments).	Recovered.	Magendie.
Gr. j.	Dog.	Injected into jugular vein.	Tetanic spasms.	Death in a few seconds.	Magendie.
Gr. j.	Dog.	Injected into peritoneum.	Tetanic spasms.	Death in 9 minutes.	Magendie.

In the human subject the 1-16th of a grain has produced dangerous symptoms, accompanied with collapse.

Treatment.

The treatment must consist in the administration of emetics, the use of the stomach-pump and powdered charcoal, tannin infusions, and stimulants, whilst opium combined with purgatives may afterwards be useful, if the patient can bear them.

Cases of Poisoning with Veratria.

VERATRIA.		
1. Taylor's "Medical Jurisprudence," vol. i., p. 332 (Mr. Callaway). Female. $\frac{1}{16}$ of a grain.		
Symptoms.—After a short time was found insensible; surface cold; pulse failing, and apparently dying.	*Result.*—Recovery.	
2. Dr. Percy's Prize Essay, 1864, p. 76. Male: adult. 30 grains of crude veratria prepared from V. viride.		
Symptoms.—Vomiting; prostration; loss of pulse; recovery on third day.	*Result.*—Recovery.	

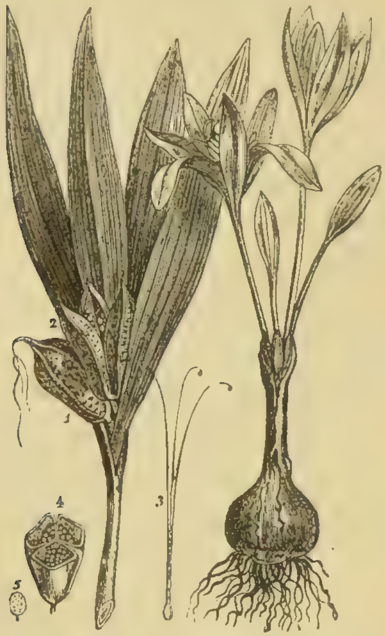
Colchicum Autumnale. (Fig. 32.)

(Colchicum—Meadow Saffron—Autumn Crocus.)

All parts of this plant, even the flowers, are poisonous, the bulb and seeds being especially active. It has a fibrous root, and an underground stem or corm.

The corm or bulb is white internally, and has a brown external coat. A milky juice flows out when the fresh bulb is cut. Its taste is bitter and acrid.

FIG. 32.



The seeds are of a reddish brown colour externally, and white internally. In appearance they are hard, spherical, and shrivelled (from 8 to 12 to 1 grain, Guy). They have a bitter taste, but no smell.

As a medicine, the action of colchicum is uncertain. Its activity varies according to the season in which it is gathered (Orfila and Christison), its energy being greatest in the autumn (Buchner).

It contains a peculiar acid called Civadic Acid.

Its active principle is

Colchicinia or *Colchicin.*

Colchicin is supposed by some to be identical with veratria, but of this there is considerable doubt. It does not produce the violent sneezing peculiar to veratria. It is slightly soluble in water, the solution being alkaline, but is not so soluble as veratria. It is freely soluble in alcohol. It gives with nitric acid a reddish violet colour, which very soon passes off.

Symptoms, Dose, &c.

The symptoms in the human subject may commence immediately, but are, at any rate, rarely delayed beyond three hours. Pain, vomiting, purging, the stools being frequently mixed with blood, cramps and occasionally convulsions, great irritation in the throat, thirst, dilated pupils, with great coldness and prostration, are the commonly observed symptoms. Not unusually they closely resemble malignant cholera in their nature. Delirium and suppression of urine have been occasionally noticed. In several cases relapse and death have occurred, where for a time the urgent symptoms seemed to yield to treatment. Death has taken place in seven hours, whilst it has been delayed for eight days, but in the majority of cases it occurs within twenty-four hours. One ounce of the wine, forty-eight grains of the dried bulb, a tablespoonful of the seeds, two ounces of the cooked leaves, and a handful of the flowers have, severally, caused death. Recovery is recorded after one ounce of the wine and one ounce of the tincture respectively.

Post-Mortem Appearances.

In nearly all cases the stomach and intestines are found inflamed. In two cases no redness was noticed, and in one case the stomach was said to be grey and brittle. Frequently, purple patches will be observed on the skin, and occasionally, on the internal organs. The liver, spleen, brain, and spinal cord are usually congested, the bladder empty, and the heart full of coagulated blood.

Colchicum has been administered criminally (Reg. *v.* Catherine Wilson, C. C. C., Sept., 1862, murder of Mrs. Soames).

Experiments on Animals.

Two drams of the dried bulb given by the mouth was found to kill a dog (Störck). A similar quantity dissolved in sherry and the soluble portion injected into the jugular vein of a dog, caused death in five hours, with vomiting, diarrhœa, and great prostration. Of colchicine, the 1-10th of a grain killed a cat in twelve hours, vomiting, purging, staggering, and salivation being produced.

Cases of Poisoning by Colchicum.

<table>
<tr><td colspan="3">1.
Taylor's "Medical Jurisprudence," vol. i., p. 330. Male. ʒiss of wine of colchicum.</td></tr>
<tr><td><i>Symptoms.</i>—Immediate pain in abdomen; death.</td><td><i>Result.</i>—Death in 7 hours.</td><td></td></tr>
<tr><td colspan="3">2.
Schneider's "Annalen," vol. i., p. 232. ℥j of wine of colchicum.</td></tr>
<tr><td></td><td><i>Result.</i>—Death in 39 hours.</td><td></td></tr>
<tr><td colspan="3">3.
"L'Union Médicale," Aug. 24, 1848. ℥j of wine of colchicum.</td></tr>
<tr><td><i>Symptoms.</i>—Cramps in limbs; twitchings of tendons.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">4.
"American Journal of Medical Science," Jan., 1857. Female: æt. 56. ℥j of the wine taken in the course of 12 hours in divided doses.</td></tr>
<tr><td><i>Symptoms.</i>—Nausea; vomiting; slight purging; heat and pain in throat; thirst; clammy skin; feeble pulse; pain in stomach, which continued for 3 days.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">5.
"Medical Gazette," vol. x., p. 160 (Mr. Fereday Dudley). Male. ʒij of wine of colchicum (seeds).</td></tr>
<tr><td><i>Symptoms.</i>—Vomiting in 1½ hour; great pain; tenesmus and thirst; no convulsions, or insensibility; suppression of urine; weakness of limbs; and before death dark watery purging.</td><td><i>Result.</i>—Death in 48 hours</td><td><i>Post-mortem.</i>—A patch of redness found in stomach near the cardiac end; jejunum inflamed; bladder empty; purple patches on the skin.</td></tr>
<tr><td colspan="3">6.
Taylor's "Medical Jurisprudence," vol. i., p. 330 (Mr. Mann). ʒiiss of colchicum wine in divided doses.</td></tr>
<tr><td></td><td><i>Result.</i>—Death on the 4th day.</td><td><i>Post-mortem.</i>—No inflammation of mucous membrane found, but simply extravasation of blood into the mucous follicles.</td></tr>
</table>

7.

"Edinburgh Medical and Surgical Journal," vol. xiv., p. 262. Male. ℥iss of wine made from bulb.

Symptoms.—Vomiting; pain; purging; colic; delirium; death.	*Result.*—Death in 2 days.	*Post-mortem.*—No morbid appearances.

8.

"Christison," p. 882. Three soldiers. 18 ozs. of colchicum wine.

Symptoms.—The first had symptoms of malignant cholera; death in 2 days from collapse.	*Result.*—(1) Death in 2 days.	
The other two had similar symptoms, passing into dysentery; death in a few weeks.	*Result.*—(2 and 3) Death after a few weeks.	

9.

"Annales d' Hygiène Publique," vol. xvi., p. 394 (M. Caffe). Female. ℥v of wine containing the active matter of ¼lb. of the bulb.

Symptoms.—Pain, vomiting and coldness came on rapidly; oppression in breathing; great prostration; cramps; no purging, or delirium, or convulsions, or change in pupil; death.	*Result.*—Death in 22 hours.	*Post-mortem.*—Cerebral vessels congested; coagulated blood in heart; stomach brittle and grey; Peyer's patches very livid and distinct.

10.

"Annales d' Hygiène Publique," vol. xii., p. 397. Female (sister of last case). ℥v of wine, containing ¼lb. of bulb.

Symptoms.—Similar symptoms.	*Result.*—Death in 28 hours.	*Post-mortem.*—Putrefaction after 48 hours so far advanced as to render results uncertain.

11.

"Lancet," April 4, 1840, p. 62; "Journ. de Chemie Médicale," vol. viii., p. 351, Dec., 1839 (Chevallier). Male: æt. 50. Wine made from the bulb.

Symptoms.—Pain, thirst, vomiting.	*Result.*—Death in 3 days.	*Post-mortem.*—No morbid appearances.

12.

Reese, "Manual of Toxicology," p. 335. Eight or ten persons drank wine of colchicum, believing it to be sherry, at Montreal, Nov., 1873.

Symptoms.—Nausea, severe vomiting, abdominal pains, cramps, purging, and prostration. Five died.	*Result.*—Death and recovery.	

13.

"L'Union Médicale," March 27, 1855; "Lancet," May 5, 1855. (M. Joules Roux, of the Toulon Galley Slave Hospital.) Five men took ℥ij of colchicum wine each in mistake for bark wine.

Symptoms—Symptoms began in about 2 hours. All five died: three within 19 hours, and two within 26 hours. Severe pain, nausea, constant vomiting; diarrhœa, but no blood in stools. Mental faculties unimpaired.	*Result.*—Death. 3 within 19 hours and 2 in from 19 to 26 hours.	*Post-mortem.*—No inflammation or ulceration in pharynx or œsophagus; stomach and intestines soft and red, but not ulcerated; liver and spleen congested; strongly marked vascularity in brain and spinal cord; muscular tissue very rosy.

14.

"Medical Times and Gazette," March 7, 1874, p. 275 (Dr. Major). Colchicum wine made of four ozs. of seeds to one pint, swallowed by 17 thieves, each taking from 3 to 11 ounces of the wine.

Symptoms.—Vomiting and bilious discharges set in after from 45 to 90 minutes; purging came on simultaneously when the quantity taken had been large, but was delayed otherwise; vomiting and purging continued to the last in the fatal cases; severe cramps; pupils slightly dilated; voice hoarse; great irritation in the throat, as if there was laryngitis; thirst intense; pulse small. For several hours before death the beating of the heart could only be heard with difficulty. They remained sensible to the last, the muscular strength being retained. They were all sleepless. In seven fatal cases the ages were from 12 to 45, and the patients lived from 19 to 29 hours. One man æt. 35, who took 11 oz., recovered.	*Result.*—Death in 7 cases in from 19 to 29 hours. Ten recovered.	

15.

"Edinburgh Medical and Surgical Journal," vol. lvi., p. 186 (Dr. Lewins, Jun.). ʒi of tincture of the seeds taken three times daily.

Symptoms.—Dangerous symptoms.	*Result.*—Recovery.	

16.

"Medical Times and Gazette," Jan. 15, 1853, p. 59. Male: adult. A wineglassful of tincture of colchicum (seeds).

Symptoms.—Violent pain and vomiting.	*Result.*—Death in 24 hours.	

17.

"Lancet," June 10, 1848, p. 642 (M. Renauldin). Female. ℥i of tincture.

Symptoms.—Pain and vomiting (emetics given).	*Result.*—Recovery in 8 days.	

18.

"Lancet," Jan. 8, 1853, p. 45. Male. ℥ij of tincture.

Symptoms.—Pain and vomiting.	*Result.*—Death.	

19.

"Journal de Chemie Médicale," 1839, p. 589 (M. Ollivier). Two cases. A dose of the tincture containing about 48 grains of dried bulb.

	Result.—Both died within 24 hours.	

20.

"Journal de Chemie Médicale," 1839, p. 589 (M. Ollivier). Watery extract of 138 grains of dried bulb taken in three doses. (July.)

Symptoms.—Purging and prostration. No head symptoms.	*Result.*—Death in 3 days.	

21.

"London Medical Gazette," 1838-9, vol. ii., p. 763 (Mr. Henderson). ℥j of tincture.

Symptoms.—No symptoms for three hours, when pain, vomiting, purging, numbness and pricking came on. On the second day pain in the joints, sweating, and lightness of head set in.	*Result.*—Recovery.	

<table>
<tr><td colspan="3">22.
"Medical Times," Dec. 19, 1810, p. 137. Male: adult. Decoction of colchicum seeds (large spoonful).</td></tr>
<tr><td><i>Symptoms.</i>—Fifteen stools and vomitings occurred within a few hours. On the second day the diarrhœa a little abated. On the third day respiration became hurried, pupils dilated, stomach painful.</td><td><i>Result.</i>—Death on the third day.</td><td><i>Post-mortem.</i>—Abdomen hard, and covered externally with violet and greenish-blue patches; surface of heart covered with brownish spots; stomach violet-coloured; veins of stomach and intestines filled with black blood; very little inflammation in intestines.</td></tr>
<tr><td colspan="3">23.
"Lancet," Aug. 18, 1860, p. 177. Two children. Seeds.</td></tr>
<tr><td></td><td><i>Result.</i>—Death.</td><td></td></tr>
<tr><td colspan="3">24.
"Beiträge," vol. iv., p. 246 (Bernt). Two children. A handful of colchicum seeds.</td></tr>
<tr><td><i>Symptoms.</i>—Vomiting, purging.</td><td><i>Result.</i>—Death in 24 hours.</td><td><i>Post-mortem.</i>—Redness of stomach and small intestines.</td></tr>
<tr><td colspan="3">25.
"Christison," p 883 (Blumhardt). Male. Infusion of a teaspoonful of the seeds.</td></tr>
<tr><td><i>Symptoms.</i>—Diarrhœa, griping, and vomiting after ¾ hour. In twelve hours seemed better, and free from pain. The next day all symptoms returned, and he died about 12 o'clock.</td><td><i>Result.</i>—Death.</td><td><i>Post-mortem.</i>—Twenty-three hours after death muscles were rigid; heart and great vessels contained coagulated blood; gullet at cardiac end inflamed; stomach and intestines more or less inflamed.</td></tr>
<tr><td colspan="3">26.
"Christison," p. 884 (Dr. Bleifus). Male. 2 oz. of cooked leaves gathered in May.</td></tr>
<tr><td><i>Symptoms.</i>—Vomiting and purging occurred in six hours. In 15 hours symptoms of malignant cholera set in. Mind clear; pain in the stomach; coldness of skin, and cramps. On the third day became rapidly worse.</td><td><i>Result.</i>—Death on the third day.</td><td></td></tr>
<tr><td colspan="3">27.
"Medical Times and Gazette," Dec. 26, 1874, p. 723 (Mr. Porter and Dr. Tidy). Two children.</td></tr>
<tr><td><i>Symptoms.</i>—Insensibility and convulsions; thirst, vomiting, and purging.</td><td><i>Result.</i>—Death in 24 hours in both cases.</td><td><i>Post-mortem.</i>—Colchicum seeds found, and also a substance like colchicin in the blood.
Lungs congested; mucous membrane of stomach somewhat inflamed; large intestines very inflamed.</td></tr>
<tr><td colspan="3">28.
"Magazin für Pharmacie," vol. xxx., p. 237 (Geiger). Decoction of a handful of the flowers.</td></tr>
<tr><td><i>Symptoms.</i>—Vomiting, purging.</td><td><i>Result.</i>—Death in 24 hours.</td><td><i>Post-mortem.</i>—Inflammation of stomach and duodenum only.</td></tr>
</table>

See also the following cases of Colchicum Poisoning:—

"Medical Times and Gazette," March 12, 1864, p. 288 (Reg. *v.* Markuss: given by herb doctor).
" " Oct. 27, 1860, p. 420 (death from overdose of tincture).
"Medical Times," July 15, 1843, p. 253 (death after taking ℥vj of Tincture).
"Pharmaceutical Journal," July, 1861, p. 45.

Veratrum Album. (Fig. 33.)

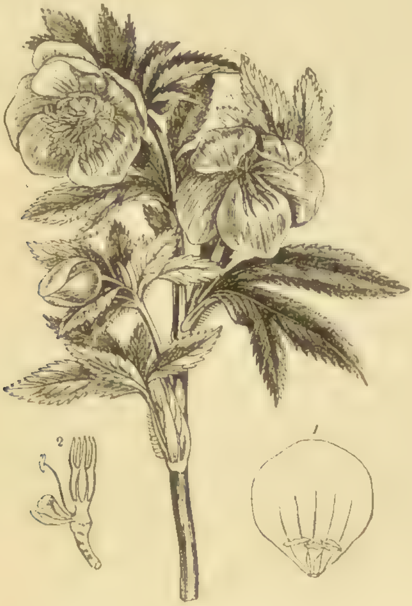
(White Hellebore.)

The white Hellebore acts as a poison to all animals, however administered. All parts of the plant are poisonous, but more particularly the root or rhizome. It is exceedingly bitter to taste, and produces violent sneezing when applied to the nose. It is used for the destruction of vermin.

The poisonous action of the plant is due to the presence of the alkaloid *veratria.* Three other alkaloids are said to have been found in the plant, and have been called respectively *Sabadillia, Colchicia,* and *Jervia.*

White Hellebore is a powerful irritant poison. Three grains of the extract applied to the nostril of a cat killed it in three hours, whilst a dog died from the application of twenty grains.

FIG. 33.



Pain, giddiness, vomiting, insensibility, convulsive movements, dilated pupils, and in one case blindness, are the recorded symptoms. Death in one case occurred in twelve hours. The post-mortem appearances are those produced by an irritant poison.

Cases of Poisoning with the White Hellebore.

1.		
Rust's "Journal;" "Christison," p. 879. Family of eight persons ate bread containing powdered root which had been added by mistake.		
Symptoms.—Pain, swelling of tongue, giddiness.	*Result.*—Recovery.	
2.		
Horn's "Archiv.," 1825. Family of three persons ate the root by mistake.		
Symptoms.—Burning in throat, nausea, and vomiting came on in one hour; giddiness, blindness, and dilated pupils; faintness; convulsive breathing; in one case great lethargy, and an eruption like flea-bites.	*Result.*—Recovery.	

3. "Christison," p. 880. Male. Quantity (?)		
Symptoms.—Violent vomiting. Death.	*Result.*—Death in 12 hours.	*Post-mortem.* — Gullet, stomach, and colon inflamed.
4. Stillé's "Materia Medica," vol. iv., p. 314. Two children: æt. 3½ and 1½. Decoction of white hellebore.		
Symptoms. — Vomiting, insensibility, spasmodic movements of face and limbs; pupils dilated.	*Result.*—Recovery.	
5. "Lancet," July 4, 1857, p. 9 (Mr. Giles). Male. ℥ss of powdered white hellebore taken by mistake for cream of tartar.		
Symptoms.—Pain and sickness in four hours. No vomiting occurred until after emetics had been given. No convulsions.	*Result.*—Recovery.	

Heleborus Viridis.

Veratrum Viride.

(American or Green Hellebore—Indian Poke—Swamp Hellebore.)

All parts of the plant are bitter and nauseous.

It is said to contain two alkaloids (Bullock.) :—

1. *Veratroidia* (like veratria) which is soluble in ether. Like veratria it causes sneezing, but it has a higher melting point. Sulphuric acid turns it an intensely red colour, whilst hydrochloric acid has no action upon it even when heated.
2. *Viridia,* which is insoluble in ether.

We believe, however, there is little doubt but that veratroidia is identical with veratria.

The symptoms produced by the green hellebore set in, in from half an hour to some few hours. Vomiting and purging, cold perspirations, an almost imperceptible pulse, pain, in some cases loss of speech, with great prostration and collapse are common symptoms. Death has occurred in thirteen hours, and been delayed for four weeks. Seventy drops of the extract has killed an adult, and thirty to forty drops of the tincture has proved fatal to an infant. Recovery is recorded after a dram of the tincture, and a teaspoonful of the fluid extract. No special post-mortem appearances are recorded.

Cases of Poisoning with Veratrum Viride.

1. "Medical Times and Gazette," 1863, vol. i., p. 5 (Dr. Edwards). Male. ʒj of the tincture of green hellebore = 12 grains of powder.		
Symptoms. — Collapse; features sunk; skin cold and perspiring; pulse scarcely perceptible; pain in stomach, but no purging.	*Result.*—Recovery.	

2.

"American Journal of Medical Science," July, 1865, p. 284 (Dr. J. C. Harris). Æt. 18 months. Four or five doses of four drops, and one dose of 16 drops, of tincture of veratrum viride.

Symptoms.—Attempt to vomit; unconsciousness and stertorous breathing set in in seven hours after the first dose; pulse slow; cold perspiration.	*Result.*—Death in 13 hours.	

3.

"Buffalo Medical and Surgical Journal." Nov. 1866, p. 133 (Dr. T. M. Johnson). Female: æt. 50. Seventy drops of Tilden's fluid, (extract of veratrum viride), taken in two doses.

Symptoms.—Pain in stomach, nausea, and vomiting occurred in two hours after the first dose. In two hours after the second dose the symptoms increased in severity, with great prostration. After 12 hours the stools were bloody. Vomiting continued for four weeks, when she died.	*Result.*—Death after 4 weeks.	*Post-mortem.*—Nothing noticed in the post-mortem except that the stomach was unusually small in size.

4.

"American Journal of Medical Science," Oct. 1865, p. 563 (Dr. J. B. Buckingham). Male: adult. A teaspoonful of the fluid extract of green hellebore.

Symptoms. — In 30 minutes became speechless; retching and vomiting; pulse almost imperceptible; cold perspirations.	*Result.*—Recovery.	

5.

"American Journal of Medical Science," Oct. 1865, p. 563 (Dr. J. B. Buckingham). Male: adult. A teaspoonful of the fluid extract of green hellebore.

Symptoms.—Symptoms similar to last case, with loss of speech and of locomotion.	*Result.*—Recovery.	

MENISPERMACEÆ.

Menispermum (*or Anamirta*) *Cocculus.*

(The fruit is known as the Cocculus Indicus or Levant Nut).

This plant is a climbing shrub growing in the East Indies.

The fruit, which is known as the Cocculus Indicus, is like a large dark brown pea, and consists of two parts, husk and kernel, the former being dark brown in colour, and fibrous in structure, and the latter yellowish and oily. The *shell portion* has an emetic action and contains a non-poisonous alkaloid called *menispermine* (C_{18} H_{21} N_2 O.) The *kernel portion* is very poisonous, the active principle called *picrotoxine* (C_5 H_6 O_2) being present in quantities varying from 1 to 2 per cent.

We have here an illustration of a very poisonous substance, completely inclosed in a non-poisonous husk. Is the administration of the *whole seed*, which may pass through the body, possibly without producing any bad results, to be legally regarded as the administration of a poison? It was decided that the administration of a poison with *intent* to murder, although by good fortune it was so administered that it would not act, was to be regarded as the administration of a poison within the meaning of the statute. (*Reg.* v. *Cluderay*, Jan. 19, 1849, page 32.)

Uses.

Cocculus Indicus has acquired some notoriety from its having been used for several improper purposes. It has been employed for killing fish, some doubt existing as to whether the flesh of fish so killed is poisonous or not. It is also used as a bird poison ("Barber's poisoned wheat"). It has been used by thieves to produce intoxication ("hocussing") as a means of facilitating the commission of crimes. It is said to be used by brewers as a substitute for hops. The low publicans, after freely diluting their beer, increase its intoxicating properties, deteriorated by dilution, by the addition of an extract, or a decoction of cocculus indicus. For all such purposes its use is very improper.

Picrotoxine (C_5 H O_2.)

Picrotoxine is said to be a glucoside. It crystallises easily from a hot acid watery solution in colourless, stellate hexahedral crystals. Its taste is very bitter.

It is somewhat soluble in cold water (1 in 150); much more soluble in boiling water, whilst it is freely soluble in ether, chloroform, alcohol, and amylic alcohol. It is also readily soluble in an alkaline solution.

If heated very carefully it may be made to sublime, but it usually merely melts, swells up, and darkens. Cold *sulphuric acid* added to it produces either no colour or a very slight orange tint, but when the acid mixture is warmed the orange tint becomes very distinct. *Nitric* and *hydrochloric* acids dissolve it without change of colour.

It is important to note one fact proved by Mr. Langley, namely, that picrotoxine readily combines with bases, but not with acids. As a rule, in separating alkaloids we dissolve them in an acid, then throw them down by an alkali, and afterwards take up with ether. In the case of picrotoxine, we must dissolve in an alkali, and then throw down by the addition of an acid, thus reversing the ordinary process.

Symptoms—Dose, &c.

If a whole seed be swallowed, it is either soon vomited, or it else passes rapidly through the body, no bad symptoms being usually caused by it.

The action of the kernel of the nut, or of its active principle (picrotoxine), within a time varying from a few minutes to half an hour, is to produce extreme giddiness, with purging and vomiting. This passes on, sooner or later, to a form of delirium commonly accompanied by tetanic convulsions. A peculiar scarlatinal eruption has also been noticed. Lastly, there is usually intense stupor with loss of voluntary power.

Death has taken place within half an hour, whilst it has been delayed for nineteen days.

Two scruples of a picrotoxin fish composition, and a wineglassful of the decoction have proved fatal. Death has also resulted from the mere application of an alcoholic tincture to the head of a child six years old.

When beer that has been adulterated with cocculus has been drank, the intoxication produced is generally extreme, and accompanied by loss of power. A great desire for sleep is manifested after a longer or shorter period, but the sleep is frightfully disturbed, and the patient on waking dreads falling into it again. The cocculus indicus acts as a powerful excitor of all the nerve centres situated in the medulla oblongata.

Post-mortem appearances.

Sometimes no well-marked after-death appearances are found. At other times, congestion of the membranes of the brain, serous effusion into the ventricles, a softened discoloured condition of the stomach, and all the signs of peritonitis have been recorded.

Orfila found that ten grains of picrotoxine killed a dog in twenty-five minutes, tetanic spasms being the principal symptom, and that three or four drams of the powdered seed would prove fatal to large dogs.

Toxicological Analysis.

In conducting a toxicological enquiry, treat the stomach and its contents with alcohol, filter, and evaporate nearly to dryness. Treat the residue with a little water acidulated with hydrochloric acid, and shake the acid liquor up with ether. Carefully draw off the ether, when crystals of picrotoxine may be obtained on evaporation.

A similar system may be adopted with beer, as Mr. Langley proposed. We have found this process to give very good results.

The extract in the case of beer may be tested by its action on animals. In every case the physiological tests for picrotoxine should be carefully tried.

Depaire suggests another method of separating picrotoxine from beer. Shake the beer up with common salt (400 grains to 40 ounces) and filter. Exhaust the filtrate with ether, and treat the residue of the ethereal solution with alcohol and water, to which one drop of sulphuric acid has been added. This solution is to be warmed, and when cool, filtered, and again shaken up with ether, the residue from which may then be tested.

Cases of Poisoning with Cocculus Indicus.

1. Traill's "Outlines," p. 146. Several men drank rum containing the poison.		
	Result.—One died and the rest recovered.	
2. Canstatt, "Jahresbericht," 1844, vol. v., p. 298. Male: æt. 12. ʒij of a composition containing *Cocculus Indicus*, prepared for the purpose of killing fish.		
Symptoms.—In a few minutes burning pain in stomach not relieved by vomiting occurred; gastro-enteritis supervened, with delirium and purging.	*Result.*—Death on 19th day.	*Post-mortem.*—Congestion of the membranes of the brain; serous effusion into ventricles; stomach soft and discoloured; signs of peritonitis.
3. Wharton and Stillé's "Medical Jurisprudence," 1873, vol. ii., p. 596 (Dr. Fish). A quantity of the decoction given to six persons by mistake.		
Symptoms.—Convulsions occurred in two (who had taken a wineglassful) after twenty minutes. In the four (who had taken about one ounce) giddiness, nausea, and pain in abdomen set in after about thirty minutes: in one case insensibility supervened.	*Result.*—Death in the two cases in half-an-hour. *Result.* — All the remainder recovered.	

4.

"Philadelphia Medical Examiner," April, 1852. Æt. 6. Head of child washed with a alcoholic tincture.

Symptoms.—Tetanic spasms in thirty minutes, pupils contracted during convulsions, and dilated in the intervals.	*Result.*—Death in a few hours.	*Post-mortem.*—No post-mortem appearances found.

5.

"Philadelphia Medical Examiner," April, 1852. (A younger sister of the preceding case).

Symptoms.—Symptoms similar to the last case. A scarlatinal eruption appeared the day after the application.	*Result.*—Recovery.	

6.

"British Medical Journal," April 4, 1874, p. 459 (Dr. Bœttern). Four men and one woman drank ale containing *Cocculus Indicus.*

Symptoms.—Pain and vomiting set in after a quarter of an hour. In one a lichenous eruption appeared.	*Result.*—Recovery.	

OLEACEÆ.

Ligustrum Vulgare.

(Privet.)

The berries, leaves and shoots of this plant act as narcotico-irritant poisons. Three cases of death by them are recorded. The symptoms produced are vomiting, purging, drowsiness, and convulsions. The convulsions assume a severe tetanic form, opisthotonos even not being uncommon. Loss of muscular power sometimes occurs. Privet appears to have a very considerable influence both in exciting and in producing the menstrual flow, for in six children of an average age of thirteen, menstruation commenced within four days of their having eaten the berries, whilst in fourteen others the discharge returned within a fortnight.

Cases of Poisoning by Privet.

1.

Taylor's "Medical Jurisprudence,' vol. i., p. 447 (Mr. Ward of Ollerton). Three children ate the berries. (1) Male: æt. 3. (2) Female: æt. 6. (3) (?).

Symptoms.—(1) Purging and convulsions. Death.	*Result.*—(1) Death	
(2) Purging; collapse. After slightly rallying for a time, died in convulsions.	*Result.*—(2) Death	
(3) Recovery.	*Result.*—(3) Recovery.	

2.

Taylor's "Medical Jurisprudence," vol. i., p. 447 (Mr. Ward of Ollerton). Æt. 2.

Symptoms.—Signs of irritation. Death.	*Result.*—Death in 37 days.	

3.

Taylor's "Medical Jurisprudence," vol. i., p. 447 (Dr. Moore, Lancaster). Two children, æt. 12 and 8. Leaves and shoots.

Symptoms. — Drowsiness, convulsive twitchings, loss of muscular power, vomiting and purging.	*Result.*—Recovery.	

4. "Medical Times and Gazette," June 27, 1857, p. 654 (Mr. Garthon). Berries eaten by thirty-seven children.		
Symptoms.—Opisthotonos, thirst, and nausea. Tetanus, which subsided after an emetic. Recovery after about 14 days. Six children (average age 13) menstruated for the first time four days afterwards; and fourteen had a recurrence of the discharge within a fortnight.	*Result.*—Recovery.	
5. "British Medical Journal," Aug. 24, 1872, p. 209. Æt. 9. Leaves gathered in April.		
Symptoms.—Feverishness and drowsiness; purging; convulsions. At last opisthotonos.	*Result.*—Recovery.	
6. "British Medical Journal," Aug. 24, 1872, p. 209. Æt. 6. Leaves gathered in April.		
Symptoms.—Purging and other symptoms similar to above.	*Result.*—Recovery.	

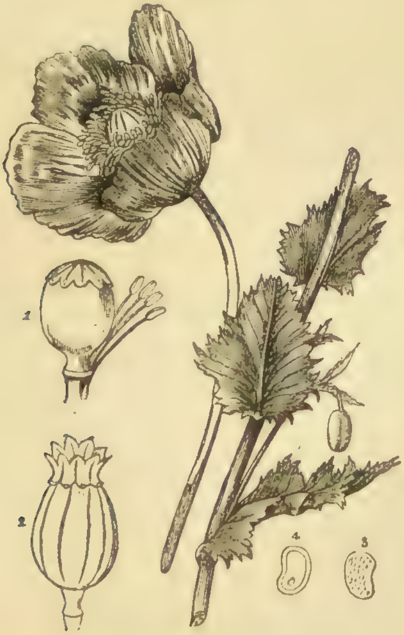
PAPAVERACEÆ.

Papaver Somniferum. (Fig. 34.)

Opium and its Preparations.

The medico-legal history of opium and its numerous preparations derive their interest, not altogether from the fact that these preparations are in themselves actively fatal poisons, but from the further circumstance that, when administered in smaller doses than is necessary to

FIG. 34.



destroy life, they serve to facilitate the commission of crimes, such as rape, theft, &c. Opium consists of the inspissated juice exuding as a white milky fluid from incisions made in the unripe fruit of the white poppy (papaver somniferum). Its odour is peculiar, and its taste bitter.

The following are analyses by Schindler of various kinds of opium as quoted by Garrod.

Dose.	Smyrna Opium.	Constantinople Opium.	Egyptian Opium.
Morphia ($C_{17} H_{19} NO_3$)	10·30	4·50	7·0
Codeia ($C_{18} H_{21} NO_3 + H_2 O$) . . .	0·25	0·52	
Narcotine ($C_{22} H_{23} NO_7$)	1·30	3·47	2·68
Narceia ($C_{23} H_{20} NO_9$)	0·71	0·42	
Meconine, or Opianyl ($C_{10} H_{10} O_4$) . .	0·08	0·30	
Meconic Acid ($C_7 H_4 O_7$)	4·70	4·38	
Peculiar Resin	10·93	8·10	
Vegetable mucus, Caoutchouc, Acid, Fat, and Vegetable Fibre	26·25	17·18	
Brown Acid, soluble in Water and Alcohol	1·04	0·40	
Brown Acid, only soluble in Water . .	40·13	56·46	
Lime	0·40	0·02	
Magnesia	0·07	0·40	
Alumina, Ferric Oxide, Silica, Calcic Phosphate	0·24	0·22	
Salts and Vegetable Oil (about) . .	0·36	0·36	
	95·76	96·73	

It is important to be familiar with the proportions of opium in the several preparations of the British Pharmacopœia.

One grain of *dried opium* is present in the following quantities of the several preparations named—

In 14·5 m. of tinctura opii (laudanum).
In 14·5 m. of vinum opii.
In ʒſs of tinctura camphora composita (paregoric elixir).
In 96 m. of tinctura opii ammoniata.
In ℥j of enema opii.
In 5 grs. of pilula saponis composita.
In 8 grs. of pilula plumbi c̄ opio.
In 10 grs. of pulvis ipecacuanhæ compositus (Dover's powder).
In 20 grs. of pulvis kino compositus.
In 40 grs. of pulvis cretæ aromaticus c̄ opio.
In 10 grs. of pulvis opii compositus.
In 13·5 grs. of unguentum gallæ c̄ opio.
In 10 opium lozenges.

One grain of opium is equivalent to about half a grain of extractum opii.

One grain of extractum opii is contained in 22 ♏ of extractum opii liquidum.

There are numerous other preparations containing opium that are well-known for their soothing properties, and from most of which fatal cases of poisoning are on record :

1. *Black drop.* This is three or four times the strength of laudanum. It consists of opium and morphia dissolved in the juice of the wild crab.
2. *Godfrey's cordial.* A mixture of sassafras, treacle, and tincture of opium (ʒj in ℥vj). (*Vide* "Lancet," Oct 9, 1852, p. 341.)
3. *Dalby's carminative.* A mixture of oils of peppermint, nutmeg, aniseed, &c., mixed with aromatic tinctures, carbonate of magnesia, and tincture of opium.
4. *Winslow's soothing syrup* ("Quietness"). Nearly one grain of morphia is present in one ounce of the syrup. ("Pharmaceutical Journal," June 1872, p. 975.)
5. *Locock's Pulmonic wafers.*
6. *Chlorodyne.* A mixture of chloroform, oil of peppermint, hydrocyanic acid and muriate of morphia; (about 2·5 grains of morphia per ℥j.)
7. *Nepenthe.* A purified alcoholic solution of meconate of morphia (Taylor), prepared by Ferris and Score.
8. *Liquor opii sedativus* (Battley). A solution of opium, said to have three times the strength of the tincture. (?)
9. *Syrup of Poppies.* The syrup should be merely a sweetened decoction of poppy heads, but it is very often made from tincture of opium. Half a teaspoonful has proved fatal to a child.

It may be remarked here that the white poppy heads grown in this country are poisonous. It is recorded that death has been caused in a child by drinking two teaspoonfuls of some water in which a poppy head had been boiled. ("Medical Times and Gazette," July 18, 1863, p. 75.)

There will be no need to discuss in detail the properties of any of the opium alkaloids, excepting morphia. *Narcotine* is asserted by some to have narcotic properties, but this has been denied by others; of *codeia,* similar contradictory statements have been made ("British Medical Journal," April 11, 1874, p. 478); of *narceia,* the best experimenters regard it as an almost inert drug, and the same may be said respecting opianyl.

Apmorphia ($C_{17} H_{17} NO_2$) was prepared as early as 1845, by acting on morphia with sulphuric or hydrochloric acid. Within the last two or three years its physiological action has received considerable attention. It is not nearly so poisonous as morphia; indeed 15 grains of apmorphia will scarcely produce so marked an effect as 5 grains of morphia. But it seems to possess powerful emetic properties. The $\frac{1}{17}$th of a grain will produce vomiting in a dog, and the $\frac{1}{8}$th of a grain injected subcutaneously will produce similar effects in a man. (M. Corville.)

See a paper on the Alkaloids of Opium by Dr. O. Hesse, in the "Deutsch-Chem. Besch. Ber. iv. p. 693.

Morphia ($C_{17} H_{19} NO_3$).

(Discovered by Sertürner in 1804.)

Morphia is the poisonous alkaloid of opium, the quantity present varying considerably in different samples of the drug. It exists in opium in the form of a meconate.

It may be estimated by the following process.

Take 100 grains of opium and rub it up in a mortar with 4 ounces of water, and boil. After allowing it to stand for some days, pour off the infusion, and again boil the residue with 2 ounces of a mixture of equal parts of alcohol and water. Filter, and add the filtrate to the original infusion. Add to this 100 grains of slaked lime, boil and filter, washing the materials on the filter paper with a little hot water. Acidulate the filtrate with hydrochloric acid, and evaporate it down to 1 ounce. Neutralize the solution with ammonia (*avoiding excess*), filter, and wash the materials on the filter paper with a little hot alcohol and water. Mix the washings with the filtrate, concentrate to about half an ounce, and when cold add ammonia in excess. After subsidence collect the morphia on a weighed filter, wash with a little cold water and dry at a moderate heat.

Good opium should yield 6 to 8 per cent. of the alkaloid.

Physical Properties.

When pure, morphia is colourless, without smell, having a very bitter taste, and crystallizing in quadrangular prisms, in which the two opposite edges are truncated, giving the crystals the appearance of being hexagonal.

Chemical Properties.

Morphia has a slightly alkaline reaction. With acids it forms salts. Two of these, the hydrochlorate and the acetate, are used in medicine. The alkaloid is precipitated from solutions of its salts by the addition of ammonia. It is readily decomposed by concentrated nitric and by hot sulphuric acids, but not by the caustic alkalies. It sublimes when heated to 165·5 C., and it melts at 171· C. If heated to a higher temperature, it burns with a smoky flame like resin, leaving a carbonaceous residue.

Solubility of Morphia in Different Liquids.

1 grain dissolves in 4,200 of cold water (15° Cent.).
1 grain ,, ,, 1,140 of hot water (100° Cent.).
1 grain ,, ,, 7,720 of absolute ether.
1 grain ,, ,, 6,509 of chloroform.
1 grain ,, ,, 4,200 of ether (s. g. 733).
1 grain ,, ,, 148 of alcohol.
1 grain ,, ,, 75 of acetic ether.

The salts of morphia are soluble in water and in dilute alcohol, but are insoluble in chloroform, ether, or acetic ether.

Like other alkaloids, morphia is precipitated by tannin. No crystals are formed (as happens with strychnia) when morphia is precipitated with either chromate of potash, sulphocyanide of potassium, or ferrocyanide of potassium.

Symptoms of Poisoning by Opium, Morphia, and their Preparations; Dose, &c.

The symptoms of opium and of morphia poisoning, vary in little else than that those of the latter set in more rapidly than those of the former. The symptoms in morphia poisoning, usually commence in from ten to thirty minutes, but with opium in from half an hour to three hours. But in this they are subject to every possible variation. Often in children the symptoms set in immediately, whilst the action of the drug is always more rapid if it be taken on an empty stomach, or in a liquid form. On the other hand, cases are recorded of considerable delay in the advent of the symptoms, cases of six, nine, twelve, fourteen, and even eighteen hours being recorded. If it be taken by a patient suffering from alcoholism, the symptoms produced by the drug may be either considerably modified, or altogether suppressed.

No matter in what form or how opium be administered, it acts as a poison. Dr. Anstie believes that the rapidity of its absorption when administered per rectum is greater than when it is administered by the mouth ("Medical Times and Gazette," March 28, 1863, p. 334).

Drowsiness and stupor are the first symptoms ordinarily observed, after a poisonous dose of opium. At first, the patient may be roused without much difficulty, and made to answer questions; but having answered them, he again rapidly subsides into his former sleep. The breathing is generally slow and almost imperceptible, and the pulse weak. If opium itself has been taken, in all probability the odour of the poison will be detected in the breath.

The general state of the pupils in poisoning by morphia, and by other alkaloids, is a matter deserving careful attention. This may be considered here. The facts may be stated as follows :—

(A) *The pupil is contracted* in poisoning by

1. Morphia and by the opium alkaloids.
2. Aconitine, and by the preparations of aconite generally, as well as by other plants belonging to the order Ranunculaceæ.
3. Physostigmine (Eserine), or the Calabar bean.
4. Strychnine, nux vomica, and Woorara poison. (?)

(B) *The pupil is dilated* in poisoning by

1. Atropine, and belladonna.
2. Stramonium, datura tatula, nicotin and other preparations of tobacco, and in poisoning by solanaceous plants generally, especially by hyoscyamin, and the other preparations of henbane.
3. Digitalin, and by the other preparations of foxglove.
4. Conia, and by the other preparations of the umbelliferæ.

There are, however, numerous exceptions to these rules, due (1) partly to the age of those who have taken the poison; for the pupil is found to be normally large in young subjects, and small in those of more advanced life. Bouchut found that the active principle of the Calabar bean, only produced contraction of the pupil in one or two out of 437 cases in which it was administered to young children. (2) The state of the pupils is also influenced by variations in the amount of moisture or the dryness of the iris (*See* Gruenhagen on "Variations in the Size of the Pupil at different Temperatures;" "Berliner Klinische Wochenschrift," January 11, 1875; and remarks, with references to the same, by Brown-Séquard, Letheby, and others, in "London Medical Record," May 12, 1875, p. 289.) (3) It is to be noted that the normal state of the pupils during sleep is *contraction.* (4) The time which has elapsed since the poisonous alkaloid was taken, or in other words, the stage of the poisoning, constitutes another cause of exceptions to the rule. It was probably from want of attention to this point, that in the celebrated trial of M. Castaing, who was executed for poisoning the brothers Ballett, by the administration, as was supposed, of the acetate of morphia, that there was so great a difference of opinion between the medical witnesses as to the effects of morphia on the pupils. Pelletan swore that it produced contraction of the pupils, whilst M. Chaussier, Orfila, and others, stated that, like other narcotics, it produced a "prodigious" dilatation of the pupils. The authors, from personal experience of the medicinal and toxic effects of opium and of its alkaloids, are able to state that in the earlier stages the pupils are contracted, whilst later on, and, as a rule after death, they are widely dilated. Again, in strychnine poisoning, the pupils are said to be dilated during the paroxysms, and contracted in the intervals. In poisoning by alcohol, the pupils are also variable. In ordinary cases of apoplexy, the pupils are unequal, whilst in apoplexy of the pons Varolii, and in large effusions of blood, especially when near the crura cerebri, the pupils are usually contracted ("Medical Times and Gazette," Feb. 28, 1863, p. 213). During an epileptic paroxysm they are dilated, whilst in the subsequent coma they may become small again. It is important to remember that one or both pupils may be fixed by adhesions. Aneurisms and other tumours may also cause inequality of the pupils.

The face in opium poisoning is usually very placid but pale, the lips livid, and the skin bathed in perspiration, this indeed being the only secretion probably not suspended. Sooner or later, as the case may be, the drowsiness passes on to complete coma, when it will no longer be found possible to rouse the patient. The breathing will now be slow and stertorous, and the pulse small and irregular. Cold perspirations will continue until at last the coma ends in death. But all kinds of symptoms, in addition to those mentioned, may occur. Vomiting is sometimes present, and is to be regarded as a very favourable symptom, whilst even cases where diarrhœa has occurred, are on record. Tetanoid convulsions, especially in children, and more particularly when morphia has been taken, have been recorded ("British Medical Journal," Nov. 11, 1871, p. 555). In some few remarkable cases all narcotic symptoms have been wanting. Cases have occurred where the patient seemingly recovers, enters freely into conversation, and then has a relapse and dies. Nor must we overlook the fact that other diseases may be mistaken for opium poisoning. Dr. Dobell records a remarkable case where the symptoms resulting from rupture of the bladder (uræmic poisoning), were mistaken, and not without reason, for the effects of opium ("British Medical Journal," Nov. 14, 1868, p. 520); whilst everyone is familiar with the difficulties that occasionally occur in diagnosing opium poisoning from the poisonous effects of alcohol. With both we may have complete and immediate narcotism. Sickness may be present in either case; and if present the odour of the vomit no doubt will guide us materially in our diagnosis. But then, sickness is not an invariable symptom. Vomiting and diarrhœa, at an early period of the case, indicate the exciting cause to be spirit rather than opium. Spirit generally augments the quantity of urine: opium does not, and often about the second day diminishes it. A contracted pupil is in favour of opium, a dilated pupil of alcohol, but this, as we have said, is not absolute. With spirit the breathing is generally stertorous and laborious; but with opium, it is calm and regular.

Death has taken place in as soon as forty-five minutes, whilst it has been delayed for two, three, and four days. Of forty-one fatal cases, thirty-one died in times varying from five to eighteen hours, about one-half in from six to ten hours, the most usual time being in about nine or ten hours after the poison had been taken. If a patient survives for twenty-four hours, the prognosis is favourable.

The dose necessary to destroy life is subject to numerous modifying circumstances. In the case of infants, exceedingly small quantities have been known to kill in a very short time after administration, and for this reason more than ordinary care is necessary in prescribing opium for children. Death has been caused by the $\frac{1}{8}$th, $\frac{1}{10}$th, $\frac{1}{15}$th, and even the $\frac{1}{19}$th of a grain. 2·5 minims (Dr. Christison), 3 minims (Dr. Alison), and 4 minims (Dr. Kelso), of laudanum, are recorded as having proved fatal. But, on the other hand, children have recovered after taking large doses, such as 1 grain, 5 grains, and 7·5 grains of opium ("Medical Times and Gazette," May 14, 1859, p. 505); and two teaspoonfuls of laudanum. Half a grain of acetate of morphia has proved fatal to an adult. ("Lancet," Nov. 10, 1838). We may, however, conclude that four grains of opium and one grain of a salt of morphia would, in most cases, prove poisonous doses to adults.

But the history of opium eaters, and how *use* stands out pre-eminently as a powerful circumstance in influencing the action of the drug, must not be forgotten. Thus, De Quincy, and his daily draught of nine ounces of laudanum, and the many cases recorded where thirty, and even sixty grains of opium have been taken every day for a long period, are no old women's fables. Dr. Golding Bird relates the case of a lady (æt. 26), who took ten grains of acetate of morphia three times a day for two years without any ill effects ("Lancet," May 7, 1842). A case is recorded ("Lancet," April 12, 1873), where a man took thirty grains of morphia for two consecutive days, as well as 1½ oz. of laudanum, without injury resulting. Mr. Teevan states ("Lancet," Feb. 9, 1839), that he knew a gentleman who took six grains of acetate of morphia every night for months, whilst upon one occasion, he took twenty-five grains in four doses, during twenty-four hours, and upon a second 540 grains of extract of opium in the course of seven days. But in addition to age and use, modifying the action of the poison, there are other circumstances, such as pain, individual peculiarities, disease, and particularly the habitual abuse of large quantities of alcohol, that must not be overlooked. As regards the joint action of alcohol and opium, an important question may arise as to how much opium may be safely given medicinally to a person suffering from delirium tremens. Admitting that enormous doses may often be given in such cases without danger, and indeed, with positive advantage, we must not forget that opium may kill a person fully under the influence of alcohol ("British Medical Journal," Jan. 8, 1870, p. 41, and Feb. 26, 1870, p. 212). A case is recorded where four grains of acetate of morphia caused death under such circumstances ("Lancet," Oct. 16, 1841, p. 96). Other drugs also materially influence the action of opium, and, perhaps, more especially ipecacuanha, which, for this reason, is mixed with opium in Dover's powder ("Medical Times and Gazette," May 19, 1860, p. 506).*

Treatment.

In the treatment of poisoning by morphia or by opium, the first great indication is to get rid of the poison as soon as possible. The stomach-pump must be employed, either an infusion of coffee, or green tea, or water in which a quantity of finely powdered charcoal is suspended, being used to wash out the stomach. At each separate injection a fresh quantity of the charcoal mixture, or of the tea or coffee infusion, should be used. Vomiting must be encouraged in every possible way by emetics, such as by sulphate of zinc,† repeated at short intervals if necessary, supplementing its action by tickling the throat with a feather, &c. After the emetic has done its work, a free purge, such as a full dose of calomel, may be administered with advantage. The patient should never be allowed to sleep, but must be kept continually on the move, care being taken not to produce death from muscular fatigue or exhaustion, as it is to be feared has sometimes been done. Cold water may now and then be thrown over the face and neck, and if there is thirst, nothing is better to relieve it than draughts of strong tea or coffee (*See* a Paper on the use of Caffeine in Opium Poisoning, "Medical Times and Gazette," Aug. 18, 1860, p. 168. See also Dr. Anstie's case, where caffeine was injected, after three grains of morphia had been injected by mistake: "Medical Times and Gazette," Dec. 6, 1862, p. 617). Ammonia, if there be collapse, should be applied to the nostrils, whilst galvanism often proves useful ("Medical Times and Gazette," June 26, 1847, p. 355), by exciting voluntary motions (so oxygenating the blood) without at the same time exhausting the strength (Dr Ogle, "Medical Times and Gazette," Oct. 3, 1863, p. 368).

Dr. Fuller suggested ("Lancet," March 21, 1868), a solution of iodine as an antidote. There are, however, no cases as yet recorded in which it has been tried. Tannic acid (and hence the use of strong tea) may be given, and indeed is regarded by some as the only antidote for the poison.

As regards the use of atropine in opium poisoning, we must refer the reader to the remarks already made on physiological antidotes (page 44). It is true many cases are recorded where it seems to have been successful ("Lancet," April 3, 1869, p. 473; "Philadelphia Medical Times," Nov. 29, 1873; "New York Medical Record," June 1, 1873; *see also* Dr. Harley's paper, "Pharmaceutical Journal," April, 1868, p. 471); but in nearly all the cases, it is to be noted that other remedies were adopted in addition to the atropine.

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* In a note in the "Lancet," Jan. 4, 1845, p. 25, it is stated that the coroner for New York had held, during 1844, six inquests of deaths from *opium*—one dram being the smallest, and one-and-half oz. the largest, quantity taken. Eight hours was the shortest, and twenty hours the longest, period between taking the poison and death. Twenty-three deaths occurred from laudanum—one drop being the smallest, and sixteen ozs. the largest, quantity that proved fatal. Two hours was the shortest period, forty-eight hours the longest, and twelve hours the average, time that the patient survived.

† It is well to remember that meconate of zinc is a somewhat insoluble salt. This fact may be of importance in toxicological enquiries where sulphate of zinc has been administered as an emetic.

We refer the reader to an excellent paper by Dr. Fleming ("British Medical Journal," Feb. 15, 1868, p. 137), for hints as to the treatment of habitual opium eaters.

Post-Mortem Appearances.

These are neither certain nor characteristic. The stomach and intestines generally appear healthy. After poisoning by opium the peculiar odour of the poison may often be recognised as soon as the stomach is opened. Congestion of the lungs and of the vessels of the brain, with effusion of fluid under the arachnoid and into the ventricles, are the appearances most commonly met with. The blood, too, is very generally fluid.

Tests.

The existence of opium is determined by the presence of morphia (its principal alkaloid), and meconic acid. Whether, therefore, we are conducting an examination of the contents of the stomach in a case of poisoning by pure morphia or by opium, the same course of procedure must be adopted. We shall describe (1) The tests for morphia; (2) the properties and tests for meconic acid; and (3) the method of conducting a toxicological inquiry in a case of poisoning either by opium or by morphia alone.

(A.) *Tests for Morphia and its Salts.*

1. *Nitric Acid* added to a solution of morphia turns it an orange colour. The orange-red colour, however, is far better marked when the nitric acid is applied by means of a glass rod to the solid alkaloid, on a clean white plate, when effervescence will be noticed to occur, accompanied by the evolution of red fumes. The intensity of the colour is not decreased by adding chloride of tin, but is decreased by heat and by time.
2. If a drop of a carefully neutralized solution of *chloride of iron* be added to the alkaloid, a deep blue color is produced, which changes to green on the addition of an excess of the test-liquid. Persulphate of iron may be used if no free acid be present.
3. If a trace of *iodic acid* be added to a solution of morphia, the liquid becomes brown. When a drop of this solution is allowed to fall on a piece of *starch paper*, the blue iodide of starch will be immediately formed.

These three tests are, if the results be well marked, conclusive of the presence of morphia or its salts.

Other tests are as follows:—

4. If a few drops of *sulphuric acid* be added to morphia on a white plate, no change of colour will result (N.B., narcotine turns yellow). If to the acid mixture a fragment of *bichromate of potash* be now added, a bright green colour is produced from the reduction of the salt.
5. *Sulpho-molybdic Acid* gives a reddish purple, changing to green, and ultimately to blue.

Iodide of potassium gives a white crystalline precipitate, soluble in acids; *chromate of potash*, a yellow crystalline precipitate, soluble in acids; *chloride of gold*, a yellow amorphous precipitate, becoming rapidly dark-coloured; *chloride of platinum*, a yellow precipitate, soluble in acids; *iodine in iodide of potassium*, a reddish brown amorphous precipitate, soluble in caustic potash and in alcohol; *carbazotic acid*, a yellow amorphous precipitate, slightly soluble in acetic acid; *iodo-hydrargyrate of potash*, a white precipitate, soluble in alcohol and in acetic acid.

(B.) *Properties of and Tests for Meconic Acid* ($C_7 H_4 O_7$).

When pure, meconic acid is colourless, and is generally found in the form of scaly crystals. It exists in opium combined with morphia. Of itself it is not a poison.

It has powerful acid properties. It sublimes when moderately heated. It is soluble to the extent of about 1 per cent. in cold water, insoluble in chloroform, sparingly soluble in ether, and freely soluble in alcohol. It is unacted upon by the mineral acids in the cold, but is decomposed by them when heat is employed. It is decomposed by the fixed caustic alkalies.

Tests.

Two tests for meconic acid will suffice.

1. *Perchloride of iron* produces a red colour with very dilute solutions, which colour is not easily destroyed either by mineral acids or by corrosive sublimate, but is destroyed when the solution is treated with protochloride of tin. If tannic acid be present in the solution, the tannate of iron formed will serve to obscure the colour of the meconate of iron. This may be got rid of by adding a few drops of dilute sulphuric acid to the solution.

Note.

Sulpho-cyanides, acetic acid, the neutral acetates, and decoction of white mustard, also give a red colour with perchloride of iron.

(α) With *Sulpho-cyanides*, the colour is discharged by corrosive sublimate.

(β) *Acetic acid and the acetates*, give no precipitate with acetate of lead as happens with meconic acid.

(γ) With *Decoction of white mustard*, the colour is discharged by corrosive sublimate.

2. *Acetate of lead* gives a yellowish white amorphous precipitate of meconate of lead, insoluble in excess of acetic acid, but soluble in dilute nitric acid.

Other reactions of meconic acid are as follows:—*Chloride of barium* gives a white crystalline precipitate; *nitrate of silver*, a yellow amorphous precipitate; *sulphate of copper*, a greenish blue amorphous precipitate.

Toxicological Analysis.

In conducting a toxicological examination, note carefully the odour both of the internal surface and of the contents of the stomach. Sometimes the smell of opium is very apparent, whilst at other times it cannot be detected. The odour is more noticeable if the organic liquid be slightly heated. If solid opium has been taken, see whether any pieces of opium are to be found in the contents. A trial experiment may be made, by testing a few drops of the suspected opiate liquid, after filtration, first with nitric acid, when an orange colour may be produced (due to morphia), and then with a persalt of iron, which may cause a red discoloration (due to meconic acid).

Cut up all the solid matters into small pieces, and beat them into a pulpy mass in a mortar. Treat these, mixed with the liquid contents of the stomach, with spirit acidulated with acetic acid, and allow them to stand in a warm place for some time, shaking occasionally. Filter, and treat the filtrate with an excess of sub-acetate of lead, and boil. When cold, again filter and wash the materials on the filter paper with water.

First. Examine the materials on the filter paper for meconic acid as meconate of lead.

Suspend them in water in a beaker, and pass sulphuretted hydrogen through the mixture to saturation. Filter. After having reduced the filtrate to a small bulk by evaporation, test *when cold* for meconic acid with a persalt of iron.

If a red colour be thus produced, divide the coloured solution into two parts (*a* and *b*), and test respectively as follows :—

(*a*) Add a solution of corrosive sublimate (Colour not discharged).
(*b*) Add either a solution of sulphurous acid or a solution of protochloride of tin (Colour discharged).

(Other methods of decomposing the meconate of lead have been suggested, such as boiling it with a little dilute sulphuric acid, or thoroughly mixing it in a mortar with sulphate or carbonate of soda. If time allows, it is far better to decompose it with sulphuretted hydrogen.)

Secondly. Examine the filtrate for morphia.

Throw down excess of lead with sulphuretted hydrogen, which must be passed to complete saturation. Filter off the lead sulphide, and evaporate the filtrate nearly to dryness. The residue will taste bitter. Add to this a few drops of water and filter, and supersaturate the filtrate with a solution of bicarbonate of potash, and then shake up with an ethereal solution of acetic ether. Pour off the ethereal solution. Evaporate by slight heat nearly to dryness, allowing the remainder of the ether to evaporate spontaneously. The residue is to be examined for morphia by the tests already described (page 373) viz.—

(a) Nitric acid.
(β) Perchloride of iron.
(γ) Iodic acid and starch.

Failure to Detect Morphia after Death.

We must now discuss the important question : Why is it that under certain circumstances, and those circumstances apparently the most favourable, such as when large quantities of the poison have been taken, that it has been found impossible to detect a trace of either meconic acid or morphia in the contents of the stomach ; whilst in others cases, even after the person has been long dead, the poison may be easily found? The two following cases that have occurred in the practice of one of the authors will illustrate what is meant, and will possibly suggest the explanation.

A young man, J. E. H., aged 28, living in the country, had led a somewhat irregular life, suffering from time to time with fits of melancholy. One night he retired to rest somewhat earlier than usual, his relatives remarking that he seemed brighter and better than he had been for some time. In the morning, not appearing at breakfast at the usual hour, his relatives went up-stairs to call him, and were alarmed at finding him in a perfectly comatose state. A medical man was sent for. He succeeded in rousing him slightly, when he admitted that he had taken laudanum before he went to bed. This statement was confirmed by the fact that there was a recently emptied bottle of laudanum on the table, and by its side a tumbler from which he had evidently drank it. Every means to restore him was tried, but he died at 10 p.m. It is difficult to say precisely the interval that elapsed between death and the taking the drug, but it must have been somewhere about twenty-four hours.

By the coroner's orders an analysis was made of the stomach and its contents. There was no smell of opium, and the stomach seemed healthy. An analysis of one-half of the contents of the stomach for morphia and meconic acid was made, but not the slightest trace of either was discovered. The whole of the experiments were repeated on the remaining half, but were again unsuccessful. It was also examined systematically for both mineral and for other organic poisons, but with negative results.

The second case was one that excited a great amount of public interest from the mystery that seemed at the time to surround it.

A policeman, whilst on his rounds early one morning in the neighbourhood of Hackney Wick, discovered a dead body in the cupboard of an unfinished house. At the inquest it was proved to be the body of a man who had escaped some four months previously from a lunatic asylum at no very great distance from the spot where he was found. At the request of Mr. Humphreys, Mr. Gant of the Royal Free Hospital, made a post-mortem examination of the body, and although it was in a somewhat advanced state of decomposition, he was unable to detect what was, in his opinion, sufficient cause for death. The stomach was then forwarded, by the coroner's orders, for chemical examination, as well as a bottle found by the side of the deceased, labelled "Laudanum, Poison." The bottle was perfectly dry, and merely contained a small quantity of a brown deposit. This deposit was found to be opium. The stomach was in a dried-up state, and seemed covered internally with a brownish red matter. One half being submitted to analysis, morphia was detected in considerable quantity, as well as a trace of meconic acid.

These two cases may be regarded as typical cases of opium-poisoning. In the one, although it is a moral certainty that death resulted from the action of opium, the man himself confessing he had taken it—yet chemical analysis entirely failed to prove the presence of the poison. In the other, although a long period had elapsed since death, yet there was no difficulty in its detection.

And now the question suggests itself. Why in one case was its discovery so easy, and in the other impossible? There is but little doubt that the true explanation is to be found in the length of time that elapsed between death and the exhibition of the poison. The action of the living stomach on opium, and on organic poisons generally, is active and rapid. The poison may be taken, absorbed, and circulated, but if a sufficiently long time elapses before death, the medical jurist will probably fail in obtaining any evidence whatsoever of its existence.

We will not attempt here to speculate too far on the causes of all this. It may be that the poison has been removed out of the reach of analysis, passing off, if life be sufficiently prolonged, by the secretions and excretions; it may be that the quantity taken when distributed throughout the whole body is not in sufficient quantity in any one part, such as is submitted to analysis, to be discoverable, whereas, if we could experiment on the whole body we might find it; it may be that these poisons locate themselves in special parts of special viscera; or it may be (and such we deem most probable) that organic poisons when present in the living blood and in the living stomach are readily decomposed.

But on the other hand, it is unquestionable that the *dead* stomach has no action upon opium, or, indeed, upon organic poisons generally. Here, at any rate, is an illustration of how a man may be dead for four months, and yet opium be detected without difficulty. We believe Dr. Letheby has had several cases in which he has found it after even a longer period than this. And thus we were able to draw the following conclusions in this curious case:—"That the man died from the effects of opium poisoning, and that he died very shortly after having taken the drug, or otherwise it would not have been found on analysis."

Can opium be absorbed (the question has been asked) through the milk by the sucking child? (*Vide* "Lancet," Jan. 26, 1861, p. 93). There is no evidence in proof of this in the case usually quoted, inasmuch as an opiate fomentation was applied at the time to the side of the mother, this being no doubt the cause of the child's death, and not the opium that the mother had taken internally. But that such a thing as the administration of opium to a child through the milk of the nurse is possible, there can be, we should think, but very little doubt.

Cases of Poisoning with Opium.

I. LAUDANUM.		
1.		
"Lancet," Nov. 1, 1845 (Mr. Ryan). Male: æt. 61. ℥ij. The man was a drunkard.		
Symptoms. — Ordinary symptoms of great severity continued up to the third day. Recovered without either nausea, vomiting, or giddiness.	*Result.*—Recovery.	
2.		
"Lancet," Nov. 25, 1837 (Dr. Kelso). Æt. nine months. Four drops.		
Symptoms.—Ordinary symptoms set in very soon. Convulsions; pupils contracted. Death in nine hours. Every effort to save the child adopted.	*Result.*—Death in 9 hours.	*Post-mortem.*—Brain and membranes much congested; lungs a little congested; stomach healthy.

3.

"Lancet," Dec. 1, 1838, p. 389. Female: æt. 20. Twenty drops taken every evening for six days.

Symptoms.—Palpitation; dilated pupils and cold extremities; coma. Numbness of limbs, which did not disappear for 48 hours. The dilatation of pupils remained for a much longer time.	*Result.*—Recovery.	

4.

"Lancet," Oct. 31, 1840, p. 190 (Mr. Harrison). Female: æt. 32. Four dessert-spoonfuls.

Symptoms.—Complete coma; pupils contracted. Recovered in two days.	*Result.*—Recovery.	

5.

"Lancet," Oct. 16, 1841, p. 88 (Mr. Hensley). Male: æt. 42. ℥j in two doses.

Symptoms.—In six hours was absolutely comatose. (Stomach-pump and galvanism used.) Became conscious after 13 hours; recovered in nine days.	*Result.*—Recovery.	

6.

"Lancet," Feb. 19, 1842, p. 758 (Mr. Everest). Male: æt. three days. 1½m.

Symptoms.—Coma.	*Result.*—Death in 14 hours.	

7.

"Lancet," Sep. 14, 1839, p. 924 (Dr. Kelso). Male: æt. 28. Quantity (?).

Symptoms.—No effect for two or three hours, when coma supervened, and he died in eight or nine hours, without convulsions or any physical suffering.	*Result.*—Death in 8 or 9 hours.	

8.

"Provincial Journal," Jan. 28, 1846, p. 42. Male: adult. ʒvii of Battley's tincture.

Symptoms.—(Emetics given immediately); after the emetics narcotism set in. He was kept moving for 17 hours.	*Result.*—Recovery.	

9.

"Lancet," July 25, 1857, p. 80, and "American Journal of Medical Science," Jan. 1858, p. 288 (Dr. G. D. Gibb). Male: æt. 72. ℥iss of laudanum.

Symptoms.—Symptoms did not set in for nine hours, when he vomited. Pupils dilated after vomiting.	*Result.*—Recovery in 48 hours.	

10.

Stillé's "Materia Medica," vol. i., p. 671. Male. Poultice with laudanum applied to stomach.

Symptoms.—Narcotism.	*Result.*—Death.	

11.

Beck's "Medical Jurisprudence," vol. ii., p. 796. 12 drops of laudanum used as injection into rectum.

Symptoms.—Narcotism.	*Result.*—Death in 17 hours.	

12.

"American Journal of Medical Science," Oct. 1854, p. 384 (Dr. J. B. Jackson). Æt. 18 months. Five drops injected into rectum.

	Result.—Death in 6 hours.	

13.
Beck's "Medical Jurisprudence," vol. ii., p. 792. Male: adult. ℥iiss liq. opii sedativus.

Symptoms.—Total insensibility in 15 minutes.	*Result.*—Death in 1 hour and 20 minutes.	

14.
"American Journal of Medical Science," Oct. 1854, p. 383 (Dr. G. Lyman). Female: æt. 52. ℥j laudanum.

Symptoms. — Symptoms set in after 35 minutes.	*Result.*—Death in 45 minutes.	

15.
"American Journal of Medical Science," Oct. 1860, p. 570 (Dr. Campbell). Male: æt. 28. ℥iij of laudanum.

	Result.—Death in 20 hours.	

16.
"New York Medical and Physical Journal," No. xxx., p. 297 (Dr. Lee). Large quantity.

	Result.—Death in 16 hours.	*Post-mortem.*—Superficial veins of scalp full of dark uncoagulated blood; sinuses of brain full of blood; yellow serum between pia mater and arachnoid. Lungs congested; right side of heart full of coagulated blood; stomach almost natural.

17.
"Lancet," April 26, 1856, p. 467 (Dr. Simmonds). Æt. six months. A teaspoonful of laudanum.

Symptoms.—No antidote given for an hour, when the child was quite comatose.	*Result.*—Recovery.	

18.
"Lancet," Aug. 29, 1857, p. 220 (Mr. Corbet). Æt. one day. 30m. of laudanum.

Symptoms.—Coma; vomiting; convulsions; contracted pupils.	*Result.*—Recovery in 10 hours.	

19.
"Lancet," March 29, 1862, p. 326 (Dr. Slayter). Female: adult. Gin mixed with one shilling's worth of laudanum.

Symptoms.—Insensibility in three hours; pupils very contracted; involuntary passage of urine and fæces.	*Result.*—Death in 4½ hours.	*Post-mortem.*—Brain and membranes very congested; stomach congested; fluid in the brain and spinal cord smelt of spirit.

20.
"Lancet," July 18, 1846, p. 82. Æt. 9 months. About ʒss.

Symptoms.—Complete coma, contracted pupils. (Electro-galvanism only used.)	*Result.*—Recovery.	

21.
"Medical Times and Gazette," May 9, 1868, p. 497 (Dr. Tidy). (Case at Hackney Wick).
Male. Age (?). Dose (?).

When found was dead, and was proved to have been so about three months.	*Result.*—Death.	*Analysis.* — Opium discovered on analysis.

22.
"Medical Times and Gazette," July 21, 1860, p. 72 (Dr. Pearson). Æt. eight weeks. Nine drops at least.

Symptoms.—Stupor; pupils contracted.	*Result.*—Recovery.	

23.

"Medical Times and Gazette," Nov. 3, 1855, p. 445 (Dr. Sloane). Male: æt. 62. ℥ss of laudanum taken at nine p.m.

Symptoms.—Did not sleep during the night. No action for 12 hours, when complete coma set in. Pupils contracted. (Stomach-pump used; injections of ammonia and coffee; and galvanism.)	*Result.*—Recovery.	

24.

"Medical Times and Gazette," Jan. 27, 1855, p. 82 (Mr. Cleveland). Male: æt. 23. ℥ij liq. opii sedativus on empty stomach.

Symptoms.—Insensibility in half-an-hour; pupils contracted; no vomiting or perspiration. (Coffee injection used.)	*Result.*—Death in 6 hours.	*Post-mortem.*—Surface of brain much congested; no serous effusion into ventricles; lungs very congested.

25.

"British Medical Journal," Oct. 10, 1868, p. 388 (Dr. John S. Boyd). Male: æt. 32. Two ozs. of laudanum; 20 minutes after taking it, he cut his throat, but not seriously.

Symptoms.—No sleepiness for 14 hours. Died after 30 hours, perfectly comatose.	*Result.*—Death in 30 hours.	

26.

Taylor's "Medical Jurisprudence," vol. i., p. 349 (Hon. Mrs. Anson's case). Female. ℥iss of laudanum taken whilst fasting.

Symptoms.—(Emetics given in a quarter of an hour; stomach-pump used in 2½ hours), the matters pumped up had no smell of laudanum. Complete coma, and inability to swallow. This at the end of nine hours was relieved, and for five minutes she remained conscious. Coma then came on, and death occurred in 14 hours from the time when poison was taken.	*Result.*—Death in 14 hours.	

27.

"Edinburgh Medical and Surgical Journal," July, 1840 (Dr. Skae). Male: æt. 56. ʒij tincture (?).

	Result.—Death in 12 hours.	

28.

"Guy's Hospital Reports," Oct. 1850, p. 220. ℥v.

Symptoms.—No sleep produced.	*Result.*—Recovery.	

29.

"American Journal of Medical Science," Oct. 1862, p. 397 (Dr. W. F. Norris). Male: adult. ℥j laudanum.

Symptoms.—(Active measures used.) Symptoms as usual.	*Result.*—Death in 18 hours.	

30.

Wormley's "Micro-Chemistry," p. 461 (Dr. R. M. Denig). Female: æt. 17. ʒij laudanum.

Symptoms.—Stupor in three hours.	*Result.*—Death in 7 hours.	

31.

"Provincial Medical and Surgical Journal," Nov. 1841, p. 120 (Dr. Toogood). Female: æt. 55. Twelve drops of Battley's tincture.

Symptoms.—Usual symptoms.	*Result.*—Death in 24 hours.	

32.

"Lancet," Aug. 1, 1863, p. 126 (Dr. Ellis). Female: æt. 4½. ℥ss of tincture.

Symptoms.—Stupor in 15 minutes.	*Result.*—Death in 8½ hours.	

33.

"Lancet," Dec. 7, 1844, p. 317 (Dr. Lethoby). Male: æt. 56.

		Post-mortem.—Exhumation after 12 days, when opium was discovered in the body.

34.

"British Medical Journal," July 7, 1866, p. 15 (Dr. Ludlow). Male: æt. 33. About ℥j (the man had been accustomed to take it for some time).

Symptoms.—Perfect insensibility; contracted pupils; pulse imperceptible; breathing slow; breath smelt of opium. (Stomach-pump was used, but the symptoms increased. Galvanism and cold effusion were then used. Face struck constantly with wet towels, which proved successful in rousing the man; but he again went off into profound coma. Remedies had to be kept up for a long time.)	*Result.*—Recovery.	

35.

"Lancet," Aug. 20, 1842, p. 705 (Dr. Chowne). Male: æt. 23. Over ℥j; taken when drunk.

Symptoms.—In two hours became insensible, sensibility returning after 14 hours; pupils very contracted.	*Result.*—Recovery on 4th day.	

36.

"Lancet," May 1, 1841, p. 186 (Dr. R. H. Scruple). Female: æt. 19. ℥iss.

Symptoms.—Drowsiness in one hour and a half; pupils very contracted. Recovered in two or three days. (Vomiting induced by emetics.)	*Result.*—Recovery.	

37.

"Lancet," July 31, 1841, p. 661 (Dr. C. J. B. Williams). Female: æt. 26. ℥iss.

Symptoms.—Complete coma in one hour and a half. (After the stomach-pump electricity was used, and consciousness instantly restored.) Pupils contracted.	*Result.*—Recovery.	

38.

"Lancet," July 31, 1869, p. 187. Æt. five weeks. Four drops.

	Result.—Death.	

39.

"Lancet," March 29, 1873, p. 468 (Dr. Bowstead). Female: æt. 38. ℥viii.

Symptoms.—Coma; the patient not discovered for 14 hours. (Electricity used, as well as the stomach-pump.) Recovered.	*Result.*—Recovery.	

40.

"Lancet," Nov. 8, 1873, p. 684. Male. ℥ss.

Symptoms.—Pupils contracted. (ʒss of tincture of belladonna given every hour.) In six hours he was much better; but in seven hours afterwards became much worse. (The subcutaneous injection of ammonia was then tried.) Died in 18 hours.	*Result.*—Death in 18 hours.	

41.

'Lancet," Sep. 5, 1868, p. 312 (Dr. Radcliffe). Female : æt. 39. ʒiij.

Symptoms.—Scarcely sensible after 15 minutes. (Emetics and tinct. of belladonna given.) Recovered in three days.	*Result.*—Recovery.	

42.

"Lancet," Sep. 5, 1868, p. 312 (Dr. Radcliffe). Female : æt. 60. About ℥j.

Symptoms.—Insensible. (Emetics and tinct. of belladonna given.) Recovered in three days.	*Result.*—Recovery.	

43.

"Lancet," Nov. 21, 1868, p. 664 (Dr. Finlay). Female : æt. 49. Laudanum used as enema.

Symptoms—Complete coma; pupils contracted; no convulsions or paralysis. Recovered on the fourth day. (Belladonna administered.)	*Result.*—Recovery.	

44.

"Lancet," April 19, 1851, p. 435 (Dr. Deguise). Male: adult. Ten grammes instead of 10 drops given as an injection (20 drops contained one grain).

Symptoms.—Became comatose, but roused up for a time, and for 20 hours seemed to have perfectly recovered, but afterwards became worse, and died in two days after the injection had been used.	*Result.*—Death in 2 days.	

45.

"Lancet," Jan. 15, 1853 (Mr. Kirk). Male: æt. one month. Six or seven drops.

Symptoms.—Bad symptoms. (Galvanism employed.)	*Result.*—Recovery.	

46.

"Christison." Male. ℥iss laudanum.

Symptoms.—No symptoms for 18 hours; then narcotism, which continued for some hours.	*Result.*—Recovery.	

47.

"Provincial Medical Journal," Oct. 28, 1846, p. 519. Æt. five days. Two drops of laudanum = $\frac{1}{8}$th gr. of opium.

Symptoms.—Complete narcotism in five hours. Recovered for a time after a cold bath, but had a relapse, and died.	*Result.*—Death in 18 hours.	*Post-mortem.* — Brain and viscera healthy. No smell of opium in stomach.

48.

"Lancet," April 15, 1854 (Dr. E. Smith), "Medical Times and Gazette," April 15, 1854. Æt. seven days. One minim = $\frac{1}{15}$th gr. of opium.

Symptoms.—Coma in half-an-hour.	*Result.*—Death in 18 hours.	*Post-mortem.* — Heart distended with black blood; lungs collapsed, but not congested; brain congested.

49.

"Medical Times and Gazette," Jan. 10, 1861, p. 70; "Lancet," Jan. 26, 1861, p. 93. Æt. six weeks. Sucked the breast after a fomentation of gin and laudanum had been applied to the side of the mother.

Symptoms.—Coma.	*Result.*—Death.	Laudanum was given to the mother internally, and the jury supposed that the child had taken the poison through the milk.

50.

" Taylor's Medical Jurisprudence," vol. i., p. 352 (Mr. Tubbs). Æt. nine months. Two teaspoonfuls of laudanum.

	Result.—Recovery.	

51.

Taylor's "Medical Jurisprudence," vol. i., p. 352 (Dr. Proctor). Female : æt. 50. ℥j of tincture

	Result.—Death in less than 2 hours.	*Post-mortem.* — Opium found ; membranes of brain congested.

52.

" Journal de Médecine," Oct. 1846, p. 475. Male. ℥j.

Symptoms.—Convulsions.	*Result.*—Death in ¾ of an hour.	

53.

"Lancet," Dec. 1, 1849, p. 574 (Mr. Iliff). Male : æt. 10. Laudanum ; quantity (?) ; taken on an empty stomach.

Symptoms. — Insensibility in about a quarter of an hour ; pupils contracted ; vomiting. (Stomach-pump used.)	*Result.*—Recovery.	

54.

"Lancet," March 24, 1849, p. 314 (Mr. Iliff). Female : æt. 56. About ℥j.

Symptoms.—(Stomach-pump used in one hour. Galvanism also tried.)	*Result.*—Recovery.	

55.

"Lancet," Dec. 1, 1849, p. 574 (Mr. Iliff). Female : æt. 56.

Symptoms. — The above patient attempted suicide with laudanum again. (Stomach-pump and electro-galvanism again used.)	*Result.*—Recovery.	

56.

"Lancet," June 19, 1847, p. 639 (Mr. James). Female : æt. 29. ℥j of laudanum.

Symptoms.—(Stomach-pump and galvanism used in the stage of extreme coma.)	*Result.*—Recovery.	

57.

" Medical Times and Gazette," Feb. 25, 1865, p. 195. Female : æt. 11. ʒiss of laudanum.

Symptoms.—Drowsiness and perspiration soon set in ; pupils contracted. (Emetics, stomach-pump, belladonna, and electro-magnetism used.)	*Result.*—Recovery.	

58.

" Medical Times and Gazette," July 24, 1858, p. 95 (Dr. O'Rorke). Æt. five months. Laudanum (= two to three grs. of extract).

Symptoms.—Rapid stupor ; pupils contracted. (Pricking by a pin was tried in order to rouse the child ! ! !) The urine three hours after the accident found to contain morphia.	*Result.*—Recovery.	

59.

" Medical Times and Gazette," March 20, 1858, p. 292 (Dr. Mushet). Æt. three months. Dose (?).

Symptoms.—Deep coma in two hours. (Emetics and galvanism (to which the coma did not yield) were tried.)	*Result.*—Death in 56 hours.	*Post-mortem.*—Brain very pale ; bloody serum found at the base ; stomach pale.

60.

"British Medical Journal," July 9, 1870, p. 33 (Dr. Dobbie). Female: æt. 40. Two ozs. of laudanum taken on an empty stomach.

Symptoms.—No vomiting for two hours, and no other symptoms produced.	*Result.*—Recovery.	

II. OPIUM.

61.

"Lancet," Feb. 1, 1845, p. 140. Male: adult. Dose (?)

Symptoms.—Given in *delirium tremens.* Shortly became comatose, and could never be roused.	*Result.*—Death.	

62.

"Lancet," June 1, 1850, p. 698 (Dr. Guy). Male: æt. six months. 10 grains of Dover's powder = one gr. of opium.

Symptoms.—Symptoms began in three hours, and in four hours coma was complete. (Stomach-pump used.) Recovered after active means in 24 hours.	*Result.*—Recovery.	

63.

"Lancet," April 15, 1854, p. 419. Æt. five days. $\frac{1}{20}$th of a grain as a syrup (French syrup of opium).

Symptoms.—Coma in half-an-hour; pupils contracted.	*Result.*—Death in 15 hours.	*Post-mortem.*—Heart distended and brain congested.

64.

Taylor's "Medical Jurisprudence," vol. i., p. 350 (Dr. Ogston). Æt. six months. Sixty drops of wine of opium.

	Result.—Death in a few hours.	*Post-mortem.*—Brain congested; the opium was not found on analysis.

65.

Taylor's "Medical Jurisprudence," vol. i., p. 351 (Dr. Ramisch). Æt. four months. One grain of Dover's powder = 0·1 gr. of opium.

Symptoms.—Stupor, and other very severe symptoms.	*Result.*—Recovery.	

66.

Taylor's "Medical Jurisprudence," vol. i., p. 351. Æt. 4½. Four grains of Dover's powder = 0·4 gr. of opium.

Symptoms.—Coma.	*Result.*—Death in 7 hours.	

67.

Taylor's "Medical Jurisprudence," vol. i., p. 351 (Dr. Thorn). 10 grains of Dover's powder = 1·0 gr. of opium.

Symptoms.—As usual.	*Result.*—Death in 44 hours.	

68.

"American Journal of Medical Science," April, 1859, p. 367 (Dr. Hays). Æt. six. 7½ grains of opium.

Symptoms.—Narcotism never profound.	*Result.*—Recovery in 3 days.	

69.

Taylor's "Medical Jurisprudence," vol. i., p. 352. Æt. three months. Five grains.

	Result.—Recovery.	

70.

"Medical Times and Gazette," Feb. 10, 1855, p. 133 (Mr. Leigh). Male: æt. 19. Ten grains of Dover's powder (probably more).

Symptoms.—Insensibility in about four hours; contracted pupils; convulsive breathing. (Stomach-pump used.)	*Result.*—Death in 9 hours.	*Post-mortem.*—Brain congested.

71.

"Medical Gazette," vol. xxxvii., p. 235 (Dr. Sharkey), and "Medical Times," Feb. 14, 1865 p. 386. Male: æt. 32. Two pills, each containing 1¼ gr. of extract of opium = four grains of crude opium.

	Result.—Death.	*Post-mortem.*—Body warm and rigid twelve hours after death; stomach healthy; no effusion on the brain, but the sinuses and veins of the scalp and of the *dura mater* were gorged with blood. No morphia or meconic acid found. Heart nearly empty.

72.

"Medical Times and Gazette," Aug. 6, 1859, p. 145. Æt. five weeks.

	Result.—Recovery.	

73.

Taylor's "Medical Jurisprudence," vol. i., p. 355 (Dr. Brown Lahore). Male: æt. 14 months. Six grains of Dover's powder = 0·6 gr. of opium.

Symptoms.—Sleepiness in a quarter of an hour; convulsions in eight hours.	*Result.*—Death in 9 hours.	

74.

"Medical Times and Gazette," May 19, 1860 (Mr. Ewens). Æt. nine months. Five grains of Dover's powder.

	Result.—Recovery.	

75.

Taylor's "Medical Jurisprudence," vol. i., p. 355 (Mr. R. Read, Dublin). Æt. five months. Fifteen grains of Dover's powder.

Symptoms.—Active treatment adopted directly.	*Result.*—Recovery.	

76.

"American Journal of Medical Science," Oct. 1854 (Dr. Morland). Male: adult. Five grains of opium.

Symptoms.—Severe symptoms.	*Result.*—Recovery.	

77.

"Christison." Male. 4½ grains of opium mixed with nine grains of camphor.

Symptoms.—Extreme narcotism.	*Result.*—Death in 9 hours.	

78.

"American Journal of Medical Science," Oct. 1854, p. 385 (Dr. J. B. Jackson). Female. Ninety grains of opium.

Symptoms.—Not seen for three hours, when she was completely comatose.	*Result.*—Recovery.	

79.

Wormley "Micro-Chemistry," p. 462 (Dr. J. B. Thompson). Female. Sixty grains of opium and two hours afterwards $\frac{1}{2}$ oz. of laudanum, the dose being repeated in half-an-hour (= to about 100 grains of opium).

Symptoms.—No symptoms after three hours, when emetics were administered. Narcotism was at no time severe.	*Result.*—Recovery.	

80.

"American Medical Recorder," vol. xiii., p. 418 (quoted by Wormley). Female: æt. 32, pregnant. Between seven and eight ozs. of solid opium.

Symptoms.—Perfectly sensible in half-an-hour. Emetics given, which brought away about three ounces of opium. Narcotism came on, from which she recovered, but complained of violent pain in the stomach. Phrenitis set in.	*Result.*—Recovery.	

III. MORPHIA.

81.

"Lancet," Aug. 2, 1845. "Medical Times," Dec. 7, 1844, p. 214. Female: adult. $\frac{1}{32}$ gr. of muriate of morphia applied externally to the skin after a blister (two applications).

Symptoms.—Narcotism and dizziness—complained of only being able to see half of surrounding objects; convulsions.	*Result.*—Recovery in 3 weeks.	

82.

Taylor's "Medical Jurisprudence," vol. i., p. 358. Female. Thirty grains applied to an open ulcer of breast.

Symptoms.—Speedy narcotism.	*Result.*—Death in 10 hours.	

83.

"Edinburgh Monthly Journal," Sep. 1845, p. 195 (Dr. Paterson). One grain taken in solution in divided doses during six hours.

	Result.—Death in 7 hours.	

84.

Taylor's "Medical Jurisprudence," vol. i., p. 358. Male: æt. 45. One grain of the hydrochlorate in a pill.

Symptoms. — Symptoms came on in three hours.	*Result.*—Death.	*Post-mortem.* — No morphia found on analysis. Kidneys diseased.

85.

Taylor's "Medical Jurisprudence," vol. i., p. 358. Male: æt. 52. One grain.

Symptoms.—Lost hearing and smell in three hours, and rapidly became comatose.	*Result.*—Death.	

86.

Taylor's "Medical Jurisprudence," vol. i., p. 358 (Mr. De Morgan). One grain injected in three doses.

Symptoms.—After the third injection he slept for two hours, then woke up, eat his dinner and talked; after two hours became insensible, and died in another two hours, perfectly comatose.	*Result.*—Death in 6 hours.	

87.

"Chemical News," Aug. 22, 1863, p. 98. Infant. $\frac{1}{12}$ grain of the hydrochlorate.

	Result.—Death.	

88.

"Lancet," Jan. 3, 1863, p. 8 (Mr. Winterbotham). Female: æt. 2. One grain of the acetate in solution.

Symptoms.—Remained undisturbed for 2½ hours, when emetics were given. After this, drowsiness came on.	*Result.*—Recovery.	

89.

"Pharmaceuticel Journal," July, 1872, p. 16. Female. One grain of the acetate in pill.

Symptoms.—Narcotism in half-an-hour.	*Result.*—Death in [illegible] hours.	

90.

Beck's "Medical Jurisprudence," vol. ii., p. 799 (Dr. Houston). Male: æt. 59. Ten grains of the sulphate.

Symptoms.—Deep stertorous breathing.	*Result.*—Death in 2 hours.	

91.

"Christison," p. 558. Female. Ten grains of the chloride.

Symptoms.—Narcotism in 15 minutes.	*Result.*—Death in 12 hours.	

92.

"Taylor on Poisons," p. 617. Female: æt. 66. Six grains of the chloride.

	Result.—Death in 9 hours.	

93.

Orfila's "Toxicologie." Male. Twenty grains of the chloride.

Symptoms.—In ten minutes pain in stomach came on; in four hours stupor; trismus; dilated pupils; convulsions; and afterwards difficult micturition.	*Result.*—Recovery in 3 days.	

94.

Wharton and Stillé's "Medical Jurisprudence," p. 581. Male: adult. One and one-third of a grain of morphia taken in four pills at intervals of one hour.

	Result.—Death.	

95.

"Provincial Medical and Surgical Journal," Nov. 1841, p. 129 (Dr. Toogood). Female: aged Seven drops of a solution of the acetate (no strength named).

	Result.—Death in 12 hours.	

96.

"Christison." Male: adult. Fifty grains of the acetate.

Symptoms.—Narcotism in 15 minutes; vomiting induced in four hours.	*Result.*—Recovery.	

97.

"American Journal of Medical Science," Oct. 1862, p. 395 (Dr. W. F. Norris). Male: æt. 19. Seventy-five grains of the sulphate.

Symptoms.—Narcotism in one hour and a half; (emetics and belladonna given; galvanism used).	*Result.*—Recovery in 2 days.	

98.

"American Medical Intelligencer," vol. ii., p. 13. Female: aged. One grain applied to a blistered surface.

Symptoms.—Convulsions, cold sweats, and threatened suffocation after two hours.	*Result.*—Recovery.	

99.

Stillé's "Materia Medica," vol. i., p. 676. Female. One-sixteenth of a grain of the chloride applied to the denuded skin of the epigastrium.

Symptoms.—Extreme narcotism.	*Result.*—Recovery.	

100.

"Medico-Chirurgical Review," vol. xv., p. 551. Æt. 5. Ten grains of sulphate of morphia used by mistake in an enema.

Symptoms.—Narcotism in ten minutes; afterwards convulsions.	*Result.*—Death.	

101.

"New York Medical Journal," Nov. 1866 (Dr. Mitchell). Male: adult. Five grains of the sulphate of morphia.

Symptoms.—Not seen for some hours, when he had intense coma. (Belladonna enema, atropia subcutaneously injected, and galvanism were used.)	*Result.*—Recovery.	

102.

"Medical Times and Gazette," Feb. 7, 1863, p. 134 (Dr. Anstie). Male: æt. 40. Three grains of morphia injected into rectum.

Symptoms. — Deep coma; contracted pupils. Nothing done for ten hours, when the muscles of the jaw were found so contracted that they could hardly be opened. (Coffee was given, and cafeine injected). There were no convulsions.	*Result.*—Death in 16½ hours.	

103.

"Medical Times and Gazette," Sep. 1, 1860, p. 220. Æt. three days. One-third of a grain of muriate of morphia.

Symptoms.—Stupor; slow and rattling respiration.	*Result.*—Death in 17½ hours.	*Post-mortem.*—No bloody effusion found in the brain.

104.

"Medical Times and Gazette," March 7, 1857, p. 235 (Dr. Shearman). Female: æt. 26. One-fourth grain doses of the acetate of morphia.

Symptoms.— Symptoms set in, simulating strychnia poisoning; convulsions and partial opisthotonos; no coma. Great relief afforded by hydrocyanic acid. Morphia found in urine.	*Result.*—Recovery.	

105.

"Medical Times and Gazette," Sep. 26, 1874, p. 376 (Dr. Trask). Male: adult. Six grains of sulphate of morphia.

Symptoms. — In three-quarters of an hour head symptoms set in. (Emetics, and subcutaneous injection of atropia (30 m. of a solution of 1 grain to 1 ounce used, and continued with great benefit.) After this became quite unconscious. (Electricity (Faradization), poles being placed over the phrenic nerves just above the clavicles. Atropia injections then used.) Action of morphia went off after 16 hours; but then suffered from great nervous prostration.	*Result.*—Recovery.	

106.

"Lancet," Sep. 14, 1839, p. 924 (Dr. Kelso). Experiment on himself. Male. 0.5 grain of hydrochlorate of morphia.

Symptoms.—Giddiness and anxiety in two hours. Agreeable effects followed. In four hours drowsiness; exhaustion continued for a whole day.	*Result.*—Recovery.	

(IV.) MRS. WINSLOW'S SOOTHING SYRUP.

107.

"Pharmaceutical Journal," 1872, p. 618. Æt. fifteen months. Two doses.

Symptoms.—Narcotism.	*Result.*—Death.	

(V.) LOCOCK'S PULMONIC WAFERS.

108.

"Lancet," Oct. 27, 1860, p. 420 (Dr. Euston). Male: æt. 4. Ate a quantity (about 24).

Symptoms. — Symptoms of poisoning set in after about 20 minutes.	*Result.*—Recovery.	

(VI.) GODFREY'S CORDIAL

109.

"Medical Times and Gazette," Oct. 8, 1859, p. 367 (Dr. Reeves Jackson). Æt. eight months. Godfrey's cordial.

Symptoms.—In five hours stupor and apparent collapse.	*Result.*—Recovery.	

110.

"Medical Times and Gazette," Feb. 21, 1852, p. 203. Æt. six months. A pennyworth of Godfrey's cordial.

	Result.—Death in 24 hours.	

(VII.) PAREGORIC.

111.

"Medical Times and Gazette," Aug. 6, 1859, p. 145. Æt. five weeks. A teaspoonful = ʒj.

Symptoms.—Complete coma in nine hours; contracted pupils.	*Result.*—Recovery.	

112.

Taylor's "Medical Jurisprudence," vol. i., p. 352. Æt. four weeks. A dose of paregoric containing opium = $\frac{1}{50}$ of a grain.

Symptoms.—Symptoms of opium poisoning.	*Result.*—Death.	

113.

"Pharmaceutical Journal," April, 1845. Æt. seven months. Two doses of a half teaspoonful of tinct. camph. co., at interval of one day = $\frac{1}{4}$ grain of opium.

	Result.—Death.	

(VIII.) POPPIES—SYRUP OF POPPIES.

114.

"Lancet," May 12, 1838, p. 239. Æt. five months. Three teaspoonfuls of the syrup.

Symptoms.—Went to sleep in half-an-hour, and woke after an hour in great agony.	*Result.*—Death.	

115.

"Medical Times and Gazette," July 18, 1863, p. 75. Two spoonfuls of water in which a poppy-head had been boiled.

116.

Taylor's "Medical Jurisprudence," vol. i., p. 353. Æt. six months. Half a teaspoonful of syrup of poppies.

Symptoms.—Narcotism in three-quarters of an hour.	*Result.*—Death.	

117.

"Medical Times and Gazette," Jan. 20, 1855, p. 67 (Dr. Ryan). Æt. 15 months. ʒj of syrup of poppies.

Symptoms.—Symptoms set in after five hours; became quite powerless; no convulsions.	*Result.*—Death in about 8 or 10 hours.	*Post-mortem.*—Brain and membranes congested; serum in ventricles; lungs not inflamed; stomach healthy.

(IX.) CHLORODYNE.

118.

"Lancet," Nov. 11, 1871, p. 697. Female: æt. 23. An overdose.

Symptoms.—Coma.	*Result.*—Death.	

119.

"Lancet," Feb. 28, 1874, p. 322 (Dr. Farrage). Female. ʒj of chlorodyne.

Symptoms.—Intense coma; (after four-and-a-half hours a solution of ammonia was injected into a vein; and afterwards the stomach-pump was used. She gradually got better, and then belladonna was given). Return of consciousness in 12 hours.	*Result.*—Recovery.	

(X.) NEPENTHE.

120.

"Pharmaceutical Journal," 1872, p. 779. Male: æt. 14 days. Dose (?).

Symptoms. — Narcotism immediate; convulsions.	*Result.*—Death in 17 hours.	

121.

"British Medical Journal," May 4, 1872, p. 471. Dill water put by mistake in an empty nepenthe bottle.

See other Cases of Poisoning as follows:—

LAUDANUM.

"British Medical Journal," Jan. 8, 1870, p. 41. (Death from laudanum taken when drunk.)
,, Feb. 26, 1870, p. 212. ,, ,,
"Medical Times and Gazette," Jan. 4, 1862, p. 18. (Belladonna given. Recovery.)

"Medical Times," Aug. 14, 1841, p. 234. (Recovery after ʒix. No narcotism until after the stomach was emptied.
"Medical Times," Aug. 7, 1847, p. 482. (Death from two minims.)
"Dublin Medical Press," Dec. 24, 1845, p. 406.
"Medical Gazette," vol. xlv., p. 743.

MORPHIA.

"Medical Times and Gazette," Feb. 24, 1855, p. 201. (Six grains of acetate. Death)

28. RANUNCULACEÆ.

Aconitum Napellus.

(Aconite, Monkshood, Wolfsbane, Blue Rocket.)

This plant is indigenous, and is often found in our gardens, growing to a height of two to six feet. It has a spike of rich blue flowers.

The root is carrot-like, having a number of curly fibres passing off from it, and is generally from one to three inches long. At spring time a few tubers form at the crown of the root; but these soon assume the shape of the original root.

The root of the aconite has upon several occasions been mistaken for the root of the horseradish.

The root of the horseradish is—(1) long, cylindrical, and not tapering; (2) it has a light brown colour; (3) it is white when cut, and continues so for an indefinite time; and (4) it is bitter, and hot to the taste.

The root of the aconite is—(1) Short, carrot-like, and tapering; (2) it is usually brown in colour; (3) it is white when cut, but speedily becomes red; and (4) when tasted, it produces tingling and numbness about the mouth and lips.

The leaves are thick, palmate, and dark-green on the upper surface, and produce a sense of numbness when chewed.

The flowers are purple, or rich blue, and are arranged in dense racemes.

The seeds are three-sided (25 to 1 grain: *Guy*), twisted and wrinkled. One seed is sufficient to produce numbness and tingling when chewed.

All parts of the plant are poisonous. The tuber, that grows at spring time at the crown of the root, is perhaps the most active part; then the root itself, then the seeds, and then the leaves before the flowers blow. The activity of the leaves is not diminished either by drying or by keeping. It is to be noted, however, that the activity of the plant varies greatly according to the time at which it is gathered; and this circumstance is sufficient to account for the very discordant results obtained by different investigators, and to prove the need of caution in prescribing the drug, accidents having more than once arisen from a belief that a very large dose can be borne by a patient, owing to the previous administration of an almost inert preparation.

The plant owes its action to the alkaloid *aconitina* ($C_{30}\ H_{47}\ NO_7$), which is present in the plant, combined with aconitic acid ($C_6\ H_6\ O_6$). Another alkaloid (*aconella, or napellina*) is said to be present; but it is not an active agent.

The *A. ferox* (Bikh) of Bengal is probably more deadly than our monkshood. Three grains of the root has been found to kill a rabbit in nineteen minutes, and 9 grains a cat in four hours. All the aconites, however, do not seem to be poisonous, as *e.g.*, the *A. paniculatum*, the

A. casiostomum, the *A. vulparia*, the *A. variegatum*, the *A. nitidum*, the *A. pyrenaicum*, and the *A. ochroleucum*.

The *A. cammarum*, *A. lycoctonum*, and the *A. neomontanum* have severally proved fatal on different occasions.

It is stated that aconite was used by the Nepaulese to poison the water of the wells when our troops invaded their country. The soldiers suffered considerably.

Aconite has of late been extensively used in medicine. It has been found useful in neuralgia, cancer, &c., to allay pain, in heart diseases to relieve palpitation, and in dropsies as a diuretic. *Neuraline* is said to be tincture of aconite, mixed with chloroform and rose-water. It has produced poisonous symptoms. It must be remembered that the relief of pain produced by aconite is due to the local paralysis of the parts to which it is applied.

Aconitine (*Aconitina*; *Aconitia*).

$(C_{30} H_{47} NO_7)$

This is probably the most powerful poison known.

It is found generally as a white amorphous powder, but occasionally in a crystalline form. It has no smell, but an acrid taste, and is not altered by exposure to air. It is soluble in 150 parts of cold, and in 50 parts of boiling water, in about 780 parts of ether, and in any proportion in alcohol, chloroform, or benzole. The salts are freely soluble in water and in alcohol, but not in ether. If the alkaloid be heated on porcelain, it melts at about 60°C. (140 F.). It burns with a yellow flame, and leaves no residue, provided there be a free access of air. If the heat be not sufficient to fire it, a light vapour will be given off (204·5° C.), and a carbonaceous mass left behind. Sulphuric acid, when added to it in the cold, does not alter its colour, but if the mixture be warmed, it changes it to a deep brown.

Hot or cold nitric and hydrochloric acids dissolve it without any change of colour.

Every ounce of the fresh root contains from $\frac{1}{4}$ to $\frac{3}{4}$ of a grain of the alkaloid; whilst one pound of the dried root will yield from 12 to 36 grains, or in the proportion of 0·1 to 0·2 per cent.

The physiological action of commercial samples of the alkaloid varies greatly. This may, no doubt, be accounted for by the circumstance that it is frequently mixed with inert alkaloids, such as delphinia and aconella.

Symptoms—Dose, &c.

In very small medicinal doses tingling of the lips and tongue, with a slight warmth at the epigastrium, is produced.

In somewhat larger doses the tingling becomes more violent and extensive: the pulse is diminished in force and frequency: the rate of breathing decreases: any pain that may be present disappears: and the urine is often increased in quantity.

In still larger doses alarming symptoms may arise, such as extreme depression, perhaps blindness, an intense fear of impending death, but without any narcotic symptoms, or loss of the mental faculties.

We have now to consider the symptoms induced in the human subject by *a poisonous dose*, whether of the pure alkaloid, or of preparations of the several parts of the plant.

The symptoms commence in a time varying from a few minutes to one hour, with numbness and tingling, first of all in the mouth and throat, but afterwards becoming general. The heat and the parched state of the throat (often described as a feeling of constriction and burning) soon extends to the stomach, at which spot there may be considerable pain. Vomiting is a frequent, but not a universal symptom; whilst purging is not nearly so frequent. Dr. Fleming doubts if purging ever happens in a genuine case of aconite poisoning; but that it does occasionally occur we think there is little question. He argues, however, soundly, that both vomiting and purging, if they occur, may be due just as much to *local* impressions being made on the *stomach* similar to those produced on the *mouth*, as to gastro-intestinal irritation. Gradually, as the case advances, there is diminished sensibility. The skin loses its sensation, whilst there is deafness and ringing in the ears, with dimness, and perhaps loss of sight. Frothing at the mouth is not uncommon. The numbness in the limbs, with great muscular feebleness and tremblings, rapidly increase, passing on at last to complete paralysis in the lower, as well as perhaps in the upper extremities. There is often giddiness, although the mind is usually perfectly clear and collected. As the case progresses the power of speech disappears, and the breathing becomes slow and laborious, whilst the prostration of strength becomes intense. Often there is a painfully terrible dread of approaching death. The pulse from the first is slow, feeble, and irregular, becoming at last almost imperceptible. Clammy cold sweats, with intensely bloodless lips and countenance, are usual. At last suddenly, and with a few convulsive gasps (but not in convulsions, for they are very uncommon), the patient expires, the mind remaining perfectly clear to the end. Delirium even in the slightest degree is a rare symptom, and there is never any tendency to sleep, as happens with the narcotic poisons. The state of the pupils is not constant. As a rule, however, they seem to be contracted, but cases of dilatation are also recorded.

The causes of death may be one of three :—

1. *Shock.* Death from the pure alkaloid may be almost immediate by an overwhelming depression of the nervous system, the heart's action not being immediately arrested.
2. *Asphyxia.* From the suspension of the functions of respiration the result of the general paralysis. (Sir Benjamin Brodie.)
3. *Syncope.* (Headland, Harvey, and Sharpey.)

Dr. Duckworth considers that when a large dose is given, death is due to direct cardiac syncope. In smaller doses he regards death as brought about by a combination of asphyxia and syncope. ("British Medical Journal," March 2, 1861, p. 224.)

The symptoms make their appearance in from a few minutes to one or two hours; whilst death usually takes place within three or four hours. In one case it was delayed for twenty hours, whilst in another it took place in twenty minutes.

As regards the quantity necessary to prove fatal. One dram of the root, four grains of the alcoholic extract, and one ounce of the tincture have caused death. Bad symptoms have been produced by even inhaling the aconite dust whilst powdering the root. ("Medical Times and Gazette," Jan. 14, 1860, p. 43.)

Experiments on Animals.

The experiments of *Brodie* were made in 1811. He first described the leading symptoms, such as staggering, weakness, laborious respiration, and convulsive twitchings. *Orfila* in 1827 made a series of experiments, which however are of but little value. He regarded aconite as a local irritant. *Pareira* in 1842 pointed out that it produced a diminution of common sensation, so that you could stick pins in a dog that was under its influence without causing the animal pain, although no stupor or sleepiness was produced. *Dr. Fleming* in 1844 instituted some very careful experiments. The chief symptoms observed by him were weakness of the limbs, staggering, [illegible] gradually increasing paralysis of the voluntary muscles, loss or diminution of sight, slowness of pulse, difficulty of breathing, occasional convulsive movements, in two cases opisthotonos, contracted pupils, but often dilating two or three minutes before death, and death by asphyxia. He confirmed Pareira's observations of the absence of sensation without stupor being produced. He found that the heart would beat at times after breathing had ceased; that the peristaltic action of the intestines did not immediately cease after death, and that the blood was unaltered. Also, that there was general venous congestion, with distension of the right side of the heart, and venous blood in the left, as well as in the aorta; and he concludes his remarks by asserting that aconite is not an irritant poison, as it produces no increased vascularity in any part to which it is applied. As to the quantity necessary to kill animals the experiments are unsatisfactory, due to the different strengths of the different preparations employed. Dr. Wormley found 40 minims of the tincture killed a dog in sixty-four minutes, and 25 minims a cat in thirty minutes. In both cases aconite was found in the blood. Headland states that the $\frac{1}{130}$th of a grain of aconitina will kill a mouse, and the $\frac{1}{100}$th a small bird in a few minutes, whilst the $\frac{1}{5}$ th of a grain acts instantaneously. The $\frac{1}{20}$th of a grain will kill a cat, and the $\frac{1}{10}$th proved fatal to a dog in about twenty minutes. It has been stated that bad effects have been caused in the human subject by the $\frac{1}{50}$th of a grain, whilst there is every reason to believe that the $\frac{1}{10}$th of a grain may be regarded as a certainly fatal dose.

Post-mortem Appearances.

There is general venous congestion. The brain and its membranes, the liver and the lungs are usually more or less engorged. The right cavities of the heart contain more or less blood, which is generally fluid and dark. And, lastly, there is generally some signs of gastro-intestinal irritation.

Treatment.

An emetic of sulphate of zinc should be immediately administered. Finely-powdered animal charcoal, as suggested by Headland, may be given, but the stomach-pump should be used immediately afterwards. Stimulants (as ammonia and brandy), and strong coffee and tea should be administered freely. Liniments, and the application of friction to the limbs and spine, mustard-plasters to the pit of the stomach, and slight galvanic shocks through the heart, may be tried with advantage.

Much has been said about the mutual antagonism of strychnia and aconite, and judging chiefly from their different physiological effects, they have been regarded as mutual antidotes. (Vide p. 44.)

Tests for Aconitina.

1. The physiological action of the alkaloid constitutes its chief test—
   (*a*) Rubbed inside the gums, it produces a sense of tingling and numbness.
   (*β*) Administered to small animals, the symptoms already described will be produced.

2. Cold sulphuric or nitric acids have no action upon it.

With the Salts of Aconitina.

(*a*) *Caustic Alkalies* give a white precipitate.

(*β*) *Chloride of Gold* gives a yellow amorphous precipitate.

(*γ*) *Carbazotic Acid* gives a yellow amorphous precipitate, insoluble in ammonia.

(*δ*) *Iodine in Iodide of Potassium* gives both with the alkaloid and its salts a reddish-brown amorphous precipitate.

Toxicological Analysis.

In conducting a toxicological examination, search carefully for any parts of the plant that may serve for the purpose of identification. The alkaloid may be obtained in the manner already described (p. 281). The extract should be tested as to its power of producing numbness and tingling by rubbing a small portion with the finger on the lips and gums. If this fails to produce the characteristic numbness and tingling, it is a question whether further experiments will be of any avail; but it may be advisable to try its action on some small animals. The presence or absence of aconite must be judged far more by symptoms and by physiological action, than by any chemical tests.

Cases of Poisoning with Aconite.

1. “Dublin Medical Journal,” vol. 19, p. 403 (Dr. Geoghegan). Reg. *v.* McConkey.		
Symptoms.—In this case the poison was not found, but the symptoms led to a suspicion of poisoning. The man died three hours after eating some greens, prepared for him by the prisoner, and suffered from purging, lock-jaw, &c. The prisoner afterwards confessed to sprinkling the greens with powdered aconite root. A friend who tasted the greens had the characteristic symptoms of aconite poisoning, and did not recover for 5 weeks.	*Result.*—Death in 3 hours.	

2.

Taylor's "Medical Jurisprudence," vol. i., p. 426 (Mr. Hadfield). Male. Quantity (?).

Symptoms.—Four small slices of the root were taken from the stomach. Pain, thirst, vomiting, feeble pulse; perfect consciousness; no convulsions.	*Result.*—Death in 3 hours.	*Post-mortem.*—Congestion of brain and membranes; heart flaccid; blood in the right side; slight redness of mucous membrane of stomach.

3.

"Lancet," June, 1856, p. 715. Æt. two-and-half. Fresh leaves. Quantity (?).

Symptoms.—Violent vomiting.	*Result.*—Death in 20 hours.	*Post-mortem.*—Stomach very inflamed; patches of gangrenous inflammation in the small intestines; heart full of uncoagulated blood.

4.

"Christison," p. 874 (Dr. Ballardini). 12 cases.

Symptoms—Twelve cases of poisoning from the juice of the leaves, being mistaken for scurvy grass (cochlearia officinalis). Three ounces of juice were taken by each. Three of them died in three hours. In some diarrhœa was present, whilst convulsions occurred in the fatal cases.	*Result.*—Death in three out of the 12 after 3 hours.	*Post-mortem.*—Pia mater and arachnoid much injected; lungs gorged; stomach and small intestines inflamed.

5.

"Lancet," March 16, 1839, p. 905 (Mr. Dix). Male: æt. 13 months. Ate portion of root.

Symptoms.—Vomiting, dilated pupils, tendency to sleep.	*Result.*—Recovery.	

6.

Beck's "Medical Jurisprudence," vol. ii., p. 890. Male. Salad mixed with aconite.

Symptoms.—Burning pain *immediate*; tingling; numbness; muscular twitchings.	*Result.*—Recovery.	

7.

"Lancet," July 26, 1856, p. 100 (Dr. Massey). Male: æt. 48. Ate the root with bread and milk.

Symptoms.—Vomiting in a quarter of an hour; giddiness and trembling; afterwards became insensible. No diarrhœa, but an involuntary escape of a hard motion just before death.	*Result.*—Death in 2¼ hours.	*Post-mortem.*—Mucous membrane of stomach appeared of a deep chocolate colour; brain healthy.

8.

"Lancet," April 4, 1857, p. 349 (Mr. Hatfield). Male: æt. 64. Root of aconite.

Symptoms.—In half an hour violent pain, thirst, retching; no convulsions. Conscious to the last.	*Result.*—Death in 3½ hours.	*Post-mortem.*—Pupils natural; blood effused in the scalp; brain, lungs, and liver healthy; right side of the heart full of blood.

9.

"Lancet," Oct. 6, 1860, p. 344 (Mr. J. B. Brown). Female: adult. Root taken instead of horse radish.

Symptoms.—In 10 hours spasms, pricking sensations, and partial loss of sight; pulse very low; other members of the family affected similarly, some having trismus and opisthotonos.	*Result.*—Recovery.	

10.

Pareiru's "Materia Medica," vol. ii., p. 1807. 2 cases.

Symptoms.—Root mistaken for horseradish, and eaten by a man and his wife. The man ate a root and a half, and the woman half a root. Numbness and tingling came on in three quarters of an hour. The man died in four hours, and the woman recovered. No diarrhœa in either case.	*Results.* — Death in 4 hours, and recovery.	

11.

"Medical Times and Gazette," Jan. 14, 1860, p. 43. Male. Inhaling the dust whilst powdering the root.

Symptoms.—First numbness. In one hour there was difficulty of respiration, dilated pupils, loss of voice, and great prostration. Convulsions set in and lasted for five hours. Aphonia continued after a fortnight.	*Result.*—Recovery.	

12.

"Medical Gazette," vol. 19, p. 403. Male. Mlxxx of tincture of aconite. Taken in 10 doses during four days (Dr. Male of Birmingham).

	Result.—Death.	

13.

"Lancet," July 19, 1851, p. 56 (Dr. Topham). Female: æt. 27. Mxv of tincture of aconite.

Symptoms. — Symptoms immediate. Numbness, loss of power, difficulty of swallowing; convulsive twitchings of face; unconsciousness for two hours; pupils contracted. Symptoms paroxysmal.	*Result.*—Recovery.	

14.

Taylor's "Medical Jurisprudence," vol. i., p. 426. Female: adult. Mlxx of Fleming's tincture of aconite with one grain of acetate of morphia.

Symptoms.—Thirst, burning pain in stomach after a few minutes; vomiting in 15 minutes; convulsive movements; loss of power in legs.	*Result.*—Death in 4 hours.	*Post-mortem.* — Membranes of brain, but not the brain itself, congested; lungs healthy; heart flaccid; uterus congested; patches of congestion in the stomach; spots on the duodenum highly inflamed, of a dark colour, and breaking down by touch.

15.

Taylor's "Medical Jurisprudence," p. 427. Male. Merely tasted Fleming's tincture.

Symptoms.—Walked, after taking it, from the Custom House over London Bridge.	*Result.*—Death in 4 hours.	

16.

"British Medical Journal," Nov. 23, 1872, p. 579 (Dr. Henry Thompson). Male: æt. 21. One ounce of Fleming's tincture of aconite.

Symptoms.—Immediate vomiting, extreme collapse; pupils throughout more or less dilated, becoming very dilated just before death. Action of heart very tumultuous, with great general restlessness. Death in a state of syncope.	*Result.*—Death in 4 hours.	*Post-mortem.*—All the cavities of the heart contained black fluid blood; liver congested; mucous membrane of stomach and intestines reddened; spleen and kidneys congested; fluid in the ventricles, and at the base of the brain; sinuses of dura mater full of dark fluid blood.

17.

"British Medical Journal," Dec. 21, 1872, p. 682 (Dr. Dobie). Male: adult. One ounce of Fleming's tincture of aconite, taken when intoxicated.

Symptoms.—Collapse; breathing laboured. (Tincture of digitalis injected subcutaneously).	*Result.*—Recovery.	

18.

"Lancet," Feb. 23, 1867, p. 238 (Dr. Johnson). Male: æt. 61. A tablespoonful, or more (?), of Fleming's tincture.

Symptoms.—Immediate burning sensation, first in mouth, then in stomach; numbness and tingling of lips and tongue; vomiting in half an hour. In six hours became quite conscious, but very restless; pupils natural In 24 hours he was better, and rapidly recovered.	*Result.*—Recovery.	

19.

"Lancet," July 14, 1866, p. 34 (Dr. Easton). Female: æt. 17. Patient five months pregnant ʒiij Fleming's tincture of aconite taken on a full stomach.

Symptoms.—In half an hour pains in head, and tingling sensations in the body set in. The arms became benumbed, and there was partial loss of sight. She then walked half a mile, and became delirious. (Emetics given in two hours). Recovered by the next day.	*Result.*—Recovery.	

20.

"Lancet," Oct. 10, 1857, p. 379. Female. Tincture given by mistake.

	Result.—Death.	

21.

"Lancet," 1836–37, vol. ii., p. 13 (Mr. Sherwen). Tincture. Dose (?).

Symptoms.—Symptoms set in after five minutes; no vomiting; blindness, and great feebleness; pupils contracted, jaws stiff, pulse imperceptible, heart's action feeble, breathing laborious; convulsions, but perfect sensibility.	*Result.*—Recovery.	

22.

"American Journal of Medical Science," Jan., 1862, p. 285. Male: æt. five. Tincture of aconite.

Symptoms.—Aggravated symptoms. (Nux vomica was given as an antidote, and it increased the force of the heart at once.)	*Result.*—Recovery.	

23.

Taylor's "Medical Jurisprudence," vol. i., p. 427 (case of Hunt). Male. A little less than ℥j of tincture.

Symptoms.—Vomiting, pupils dilated, pain at the heart, loss of power in arms and legs, pulse imperceptible, no convulsions.	*Result.*—Death in 45 minutes.	*Post-mortem.* — Brain healthy, but the vessels very turgid; the heart healthy; right side distended with black fluid blood, left side empty; lungs healthy; stomach very congested, and mucous membrane corrugated.

24.

Pareira's "Materia Medica," vol. ii., p. 1091. Male: æt. 21. Two doses of mvj of tincture.

Symptoms.—Alarming symptoms.	*Result.*—Recovery.	

25.

"New York Journal of Medicine," Nov. 1848, p. 336 (Dr. Gray). Male: æt. 14. ℥ss of tincture of aconite.

Symptoms.—Symptoms began in five minutes. After 20 minutes there was insensibility to light and dilated pupils. Vomiting, pain in stomach; pulse slow; numbness of head. Conscious to the last.	*Result.*—Death in 2 hours.	

26.

"American Journal of Medical Science," Jan. 1852, p. 268 (Dr. McCready). Female: æt. 25. ℥ss of tincture of aconite.

Symptoms.—In one hour pupils became dilated; face flushed; pulse weak and frequent; general numbness; no vomiting.	*Result.*—Recovery.	

27.

"Lancet," March 15, 1856, p. 300, and "Lancet," April 5, 1856, p. 369 (Dr. W. H. Bone). Male: adult. A quantity of the tincture of aconite given by mistake.

Symptoms.—Symptoms almost immediate; giddiness; burning feeling along the tongue; twitches of the muscles of the face; dimness of vision; dilated pupils; involuntary escape of fæces; convulsions.	*Result.*—Death in 1½ hours.	*Post-mortem.*—Mucous membrane of stomach congested in patches; heart healthy, bladder empty.

28.

"Lancet," May 5, 1855, p. 467 (case of a suicide). Female. ʒij of tincture of aconite.

Symptoms.—Set in after four hours. When she was seen the action of the heart was scarcely audible; power of voluntary motion not impaired; consciousness; pupils dilated (one being oval in shape, and one polygonal); no vomiting or tendency to sleep; death.	*Result.*—Death in 5 hours.	*Post-mortem.*—Brain and membranes healthy; valves on the left side of heart thickened, but otherwise healthy; dark fluid blood in both ventricles; lungs healthy; stomach paler than usual; all other parts healthy; aconite found after death.

29.

"British Medical Journal," April 6, 1861, p. 360 (Dr. Thomas Skinner). Female: æt. 30. 2 m. of Fleming's tincture.

Symptoms.—Numbness and tingling, noises in ears, &c.	*Result.*—Recovery.	

30.

"Lancet," 1861, vol. ii., p. 170. Female. ʒij of the tincture taken by mistake for laudanum.

Symptoms.—Burning sensations; loss of power in legs and arms.	*Result.*—Recovery in 8 hours.	

31.

Taylor's "Medical Jurisprudence," vol. i., p. 428 (Dr. Vachell). Male. Gr. ij of the extract.

Symptoms.—Symptoms at first slow in appearing, but afterwards rapid.	*Result.*—Death.	

32.

"Medical Times," Oct. 18, 1845, p. 70 (Mr. Sayle). Male: æt. 39. Decoction of stalks and leaves.

Symptoms.—In one hour found in bed foaming at the mouth; pupils dilated; legs paralyzed; skin cold; pulse almost imperceptible; nausea; mind clear.	*Result.*—Death.	*Post-mortem.*—Redness found at the cardiac extremity of the stomach.

33.

"Medical Times and Gazette," Dec. 18, 1869, p. 709 (Dr. B. W. Richardson). Female: æt. 25. 2 tablespoonfuls of aconite lotion.

Symptoms.—In one hour and a half staggering and tingling in the face and head; vision became very imperfect; vomiting; collapse in the course of eight hours; pupils very dilated; (25 drops of liquid ammonia injected, as the patient seemed to be dead. This was repeated four times).	*Result.*—Recovery.	

See also the following Cases of Aconite Poisoning.

"British Medical Journal," May 29, 1869, p. 498. (Death. Aconite plant.)

"Medical Times and Gazette," Jan. 22, 1853, p. 103. (Case of poisoning at a Convent.)

"Medical Times and Gazette," Nov. 19, 1853, p. 543. (Mistaken for horseradish. Death.)

"Medical Times and Gazette," Feb. 2, 1856, p. 118. (Root taken for horseradish. Two deaths.

"Medical Times and Gazette," Oct. 11, 1851, p. 395. (Death from Fleming's tincture.)

"British Medical Journal," Dec. 13, 1862, p. 619. (Death from four grains of extract of aconite, given by mistake for extract of wormwood.)

ACONITINA.

34.

"Lancet," Jan 1, 1848, p. 14 (Dr. Goldingbird). Male: adult. About 2½ grains of aconitina.

Symptoms.—Fell down immediately, striking his head severely; vomiting; collapse in eight hours; surface cold and sweating; heart's action scarcely perceptible; pupils acted to light; no paralysis either of motion or sensation; intellect unimpaired; fearful spasms on attempting to swallow (symptoms like hydrophobia). The vomiting was convulsive, and really a jerking out of the contents of the stomach. There were no true convulsions.	*Result.*—Recovery.	

35.

"Chemical Gazette," vol. ii., p. 220 (M. Devay). Male: adult. ℥iss of alcholic solution.

Symptoms.—Immediate pain, and other violent symptoms.	*Result.*—Recovery.	

36.

"New York Journal of Medicine," March, 1848, p. 285. Male. Gr. iiss of aconitine.

Symptoms.—Violent vomiting, terrible collapse.	*Result.*—Recovery in 30 hours.	

37.

"Pharmaceutical Journal," Jan. 1872, p. 618. Male. Too frequent application of neuraline.

	Result.—Death.	

Anemone Pulsatilla, &c.

The most actively poisonous species of the anemone are the *A. pulsatilla* (wind-flower), the *A. hortensis,* and the *A. coronaria;* the least active being the *A. hepatica,* the *A. patens,* and the *A. Nemerosa.*

They act as irritant poisons. It is recorded by Bulliard that an old man had inflammation and gangrene by applying the bruised root of the A. pulsatilla (pasque flower) to the calf of his leg for gout. Great irritation of the eyes and nose is produced, when even the powdered root is held close to them. Animals have died from a dose of the extract, and from taking the leaves, violent inflammation of the stomach and rectum being specially noticed.

All the acridity and actively poisonous nature of the plant disappear when it has been exposed to the air for some time.

Delphinium Staphysagria, &c.

(Stavesacre, Palmated Larkspur.)

Stavesacre contains an active principle, called *Delphinia*, which is a white solid crystalline alkaloid, insoluble in water, soluble in ether and alcohol, and forms salts with acids. Six grains of this alkaloid was found to kill a dog when introduced into the stomach, in one case in forty minutes, and in other cases in from two to three hours. ℥j of the bruised seeds destroyed life in fifty-four hours, and ʒij applied to a wound killed in two days.

It acts as an irritant poison.

The *D. Tricorne* (stagger-weed) has been known to prove injurious to animals.

Helleborus Niger.

(Black Hellebore, Christmas Rose.)

The Christmas rose has a black root (melampodium), which, similarly to the leaves, is capable of acting as a powerful poison.

It is used by quacks as a worm-powder, but is a dangerous drug. It is an irritant in its action, but nervous symptoms are also frequent. Its activity is due to an acrid oil, which is dissipated by boiling. Two to three drams were found to kill a dog in eighteen hours, when secured in the stomach. Two drams also killed a dog in two hours, when introduced into a wound; and similarly administered, 6 grains caused death in twenty-three hours. The irritant symptoms were accompanied with giddiness, palsy of the hind legs, and insensibility. An intense redness of the rectum was remarked if the animal lived for a few hours.

Death is recorded in the human subject from the administration of half a dram of an aqueous extract of the root.

Cases of Poisoning with Black Hellebore.

<table>
<tr><td colspan="3">1.
"Lancet," July 26, 1856, p. 100 (Dr. Massey). Female. A teacupful of an infusion of 1½ oz. of the root with 12 ozs. of water.</td></tr>
<tr><td>Symptoms.—Pain in tongue, fauces, and throat; difficulty in swallowing; pain in the stomach; tongue swollen; great collapse. Emetics were administered.</td><td>Result.—Recovery.</td><td></td></tr>
<tr><td colspan="3">2.
"De Sedibus et Causis Morborum," epist. lix., p. 15 (Morgagni). Male: æt. 50. ʒss of an aqueous extract of root.</td></tr>
<tr><td>Symptoms.—Pain and vomiting.</td><td>Result.—Death in 16 hours.</td><td>Post-mortem.—The whole alimentary canal inflamed, but especially the large intestines.</td></tr>
</table>

3. “De Sedibus et Causis Morborum,” epist. lix., p. 15 (Morgagni). Male. A tablespoonful of the finely powdered root.		
Symptoms.—Irritant symptoms. Recovery after four days.	*Result.*—Recovery.	

Helleborus Fœtidus.

(Stinking Hellebore, Bear’s-foot, Fetter-wort, Felon-grass.)

This is the most violent of the hellebores in its poisonous action.

Orfila records the death of a child from eating the root.

The *H. orientalis* (True Hellebore, Hellebore of the Ancients) is also a very poisonous plant.

Ranunculus Acris, &c.

(Crowfoot, Buttercup.)

There are fifteen varieties of Ranunculus more or less poisonous, all parts containing an acrid principle, which may be dissipated by heat and by drying. The water distilled in contact with the plant will be found to contain the acrid principle.

The various forms of Ranunculus act as irritant poisons.

The R. Acris (Buttercup) yields a juice, which is capable of acting as a vesicant, and has been used by malingerers. According to Dr. Withering it has caused death.

Krapf, experimenting on himself, found that two drops of the juice of the buttercup produced a griping pain in the gullet, similar symptoms also resulting from swallowing a single flower. If the leaves be chewed, the gums become tender, and the tongue blistered. Five ounces of the juice secured in the stomach of a dog, and two drams of the aqueous extract applied to a wound, caused death in each case in twelve hours (Orfila).

The R. Flammula is a powerful emetic. Flocks of sheep are said to have been killed by it.

29. RUTACEÆ.

Ruta Graveolens.

(Rue.)

Rue is regarded by M. Hélie as a narcotico-acrid poison. He considers that it has the greatest influence of any known substance in producing abortion, even when there is no previous tendency or special constitutional weakness. Our own experiments lead us to believe that this opinion must be received with considerable caution. It is not an active poison, although large doses kill after variable periods. Orfila found two pounds killed a dog on the second day.

Cases of Poisoning with Rue.

1. "Annales d' Hygiéne Publique," 1838, vol. xx., p. 180 (M. Hélie. Quoted by Christison). Female. Decoction of roots.		
Symptoms.—Pain, vomiting, drowsiness, giddiness, dimness of sight, difficult articulation, contracted pupils, convulsive movements of the head and arms, retention of urine, prostration; no purging. Miscarriage on the third day. At the period of the milk fever, symptoms of poisoning returned, with pain in the tongue, and salivation. Feverish symptoms set in, from which she afterwards recovered.	*Result.*—Recovery.	
2. "Annales d' Hygiéne Publique," 1838, vol. xx., p. 180 (M. Hélie. Quoted by Christison). Female. Decoction of roots.		
Symptoms.—Symptoms very mild. Miscarriage. After fifteen days entirely recovered her health.	*Result.*—Recovery.	

30. SCROPHULARIACEÆ.

Digitalis Purpurea.

(Foxglove, Purple Foxglove.)

This plant is found in gardens and hedges.

The root consists of long slender fibres.

The leaves (which are probably the most active part of the plant) are ovate or oblong, and downy on the under surface. They contain tannin.

The flowers are purple and dotted.

The seeds (1126 to a grain: Guy) are reddish-brown, small, oblong, angular, and pitted.

All parts of the plant are poisonous, and contain:—(1) *Digitaline* (1 to 2 per cent. according to some, and 10 to 12 according to others); (2) *An acrid matter*, soluble in ether, which produces vomiting, and violent head symptoms; and (3) *A bitter principle.* (M. Homolle.)

Digitaline ($C_{27} H_{45} O_{15}$).

Digitaline is a white solid, crystallizing, although with difficulty, either in scales or needles, of a bitter taste, and very irritating when applied to the nose. If burnt with free access of air, it leaves no residue. It sublimes at 154·C. (310 F.).

It is dissolved slightly both by ether and by boiling water, the solutions being very bitter. Chloroform and alcohol dissolve it freely. It is soluble in most acids, but especially in acetic acid.

Digitaline is a neutral body, and forms therefore no salts with acids. It is a glucoside. Boiled with sulphuric acid, glucose is found in solution. Heated in a tube, it gives off an acid, and not an ammoniacal vapour. It is a very active poison. Nitric acid dissolves it, the solution having a deep orange-red colour, whilst orange-coloured fumes are evolved when the acid is added to the alkaloid. Hydrochloric acid also dissolves it, the solution becoming green when heated. Sulphuric acid turns it a purple black colour, the solution when diluted becoming a dingy green. Treated with sulphuric acid, and exposed to bromine vapour, it becomes violet. This constitutes a very characteristic re-action of this body.

It is precipitated from its solutions by tannic acid, but not by chloride of mercury.

Experiments on Animals.

Experiments on animals prove that however digitaline be administered, it is an active poison. Mr. Blake found that three drams of the leaves arrested the action of the heart in five seconds. Drs. Fagge and Stevenson's experiments show that digitaline produces a peculiar form of irregularity in the beats of a frog's heart, and the retention of the voluntary power for fifteen or twenty minutes after the heart stops—a similar result happening both with squill and veratrum viride.

Symptoms, Dose, &c.

Digitalis is what is called a cumulative poison; that is, after a series of small doses have been taken apparently without any effect, the poisonous action of the drug may break out suddenly and with great violence.

There may be immediate vomiting, pain, and purging. Often, however, after even a large dose, no symptoms set in for a time, whilst all of a sudden the patient becomes insensible. The prominent symptom to be observed in digitalis poisoning is the depression of the heart's action, the pulse being irregular, and almost imperceptible. Frequently the patient will go off, for a time, to sleep, and wake up in delirium and convulsions. The pupils are dilated, the sight confused, or even lost. The sclerotic is said to have a peculiar and characteristic blue tint (Tardieu). The urine is generally suppressed, and salivation has been recorded. Towards the end of the case the faintings become constant, and death occurs usually from syncope, induced by the patient making some slight exertion, such as sitting up in bed. Dr. A. T. Thompson states that digitalis acts powerfully on the generative organs. In men and women it seems to act as an aphrodisiac. M. Gourvat ("Gaz. Méd. de Paris," Dec. 23, 1871) considers, however, that in men it tends to diminish or even to stop the secretion of liquor seminis, and that in women it has a tendency to produce strong uterine contractions. It has been extensively used as an abortive in France (Tardieu).

We have remarked that the chief symptom of digitalis poisoning is the lowering action it produces on the heart. Homolle found his pulse reduced by small doses of digitaline, taken at short intervals, to one-fourth (seventeen) the number of beats that was normal. Doses of the $\frac{1}{15}$th to the $\frac{1}{30}$th of a grain lowered the circulation in twenty-four hours, and caused vomiting and purging. Further, it was noticed that doses above the $\frac{1}{15}$th of a grain (= 8 grains of the powdered leaves) had a strong emetic and purgative action.

We may from experiments conclude that a dose of from $\frac{1}{4}$ to $\frac{1}{2}$ a grain of digitaline would prove fatal. Two or three grains of good powdered foxglove will often produce serious symptoms, although patients have recovered after taking as much as a dram. Altogether, it must be acknowledged that digitalis is a very uncertain, and because uncertain, very dangerous drug.

Death rarely occurs in less than twenty-two hours, whilst it has been delayed to the sixth day. When recovery takes place it is generally slow, and the patient is not out of danger for a very considerable time.

Treatment.

Emetics and the stomach-pump may be necessary, as at times vomiting is absent. At any rate, get rid of the poison. Tea and coffee may be given freely. Stimulants are indicated, and perhaps galvanism at the region of the heart may prove serviceable. *The patient must lie in the recumbent posture.* In no other way is the person safe, because in this position the action of the heart is less impeded than in any other. One woman died on the sixth day from merely rising up in bed suddenly.

Post-Mortem Appearances.

Of the post-mortem appearances there is little to be said. Often there is nothing abnormal to be noticed, whilst sometimes inflammation of the mucous membrane of the stomach, and injection of the membranes of the brain are met with.

Toxicological Analysis.

In a toxicological examination, the most satisfactory method is to make an alcoholic extract of the stomach and of its contents, and to experiment with this on animals. Always, if possible, preserve and examine the vomit, even if it be only a stain. And, above all, let your physiological experiments with the suspected substance, be conducted side by side with a known digitalis extract for purposes of accurate comparison.

The separation of digitaline by dialysis, as suggested by Grandeau, is questionable.

Of course any portions of leaves or seeds found in the stomach should be examined microscopically as to the botanical characteristics they present.

Cases of Poisoning with Digitalis.

1.

Case of De la Pommerais, Paris, May, 1864. *Vide* "Taylor," vol. i., p. 438, "Annales d' Hygiène," 1864 (2), p. 105. Murder of a female named Pauw, æt. 40. Prisoner was found guilty.

Symptoms.–The woman was suddenly seized with vomiting, and died in 24 hours. Vomiting, depression, and exhaustion, were the chief symptoms.	*Result.*—Death.	*Post-mortem.*—The exhumed body was examined 13 days after death. Nothing was found by chemical tests; but a rabbit died, and a dog was made ill, by taking the extract from the stomach, the chief symptom being its depressant action on the heart. The post-mortem appearances were not peculiar, but the woman before death had vomited on the floor. This was scraped up, and an alcoholic extract prepared from it. Seventy-five grains of this killed a dog, introduced into a wound, in 22 hours; vomiting and depressed cardiac action being

		well marked, but no coma or insensibility. Thirty-one grains given to a rabbit killed it in three hours—cardiac depression being the chief symptom. No effect resulted from the scrapings of the floor where the vomit had not fallen. Dr. de Pommerais had a motive and interest in her death, and was found to have previously purchased digitaline. He was executed.

2.

"Journal de Médicine," Nov. 1817. Male: æt. 55. ʒj of the powdered leaves.

Symptoms.—In 1 hour vomiting, giddiness, and loss of sight occurred; pulse very slow. Did not get well for more than 14 days.	*Result.*—Recovery.	

3.

"Medical Times," Sep. 13, 1865, p. 471. Male: æt. 34. Foxglove taken for some time.

Symptoms.—Poisoning symptoms suddenly occurred, an increase of urine being a prominent symptom. Was unconscious for some time.	*Result.*—Recovery.	

4.

"Medical Times and Gazette," Oct. 27, 1860, p. 417 (Dr. Armstrong). Female. ℥ss of infusion taken for three days every four hours; increased to ℥ij, of which she took two doses.

Symptoms.—After the second ℥ij dose she felt faint, lost her sight, and was dead almost immediately.	*Result.*—Death.	

5.

"Lancet," July 14, 1849, p. 31 (Dr. Edward). Male: æt. 70. Infusion of root given for "comfrey root" by a "quack doctoress."

Symptoms.—Dimness of vision. Patient became very faint and weak.	*Result.*—Death in 5 days.	

6.

"Edinburgh Medical and Surgical Journal," vol. 27, p. 223 (Old Bailey, Oct. 1826). Male: boy. ℥vj of a strong decoction of the leaves, given by a quack.

Symptoms.—Soon attacked with pain, vomiting, and purging. Slept soundly for some hours. On waking, vomiting returned; convulsions; pupils dilated and insensible; pulse slow and irregular. Coma.	*Result.*—Death in 22 hours.	*Post-mortem.*—Inflammation of the mucous membrane of the stomach; membranes of the brain injected.

7.

"Edinburgh Monthly Journal," 1864, p. 169 (Dr. Mazel). Female: adult. Infusion.

Symptoms. — Continuous vomiting; great pain; face pale; skin cold; great muscular weakness; feeling of being drunk; confusion of sight; pupils dilated; loss of sensibility; thirst; bowels constipated; urine suppressed; pulse slow and irregular. Death occurred suddenly, from rising in bed.	*Result.*—Death on 6th day.	

8. "London Medical Gazette," 1842–43, vol. i., p. 270. Male: adult. Infusion taken for dropsy for 20 days.		
Symptoms.—Pulse fell to half what was normal; restlessness; inability to sleep; dilated pupils; thirst; increase of urine.	*Result.*—Recovery.	
9. "Blackall on Dropsy," p. 173. ʒij of infusion taken daily.		
Symptoms.—Pain and giddiness, followed in 24 hours by convulsions, delirium, insensibility, and great depression of the heart. Died in convulsions.	*Result.*—Death.	
10. "Edinburgh Medical and Surgical Journal," vol. vii., p. 149 (Dr. Wm. Henry). Female: adult. ℥x of decoction made from two handfuls of foxglove mixed in one quart of water.		
Symptoms.—Sickness in 1 hour. For two days the patient suffered from cold sweats, sickness, salivation, very feeble pulse, and suppression of urine.	*Result.*—Recovery.	
See also the following Cases of Digitalis Poisoning. "Medical Times and Gazette," Feb. 5, 1853, p. 153. (Death.) "British Medical Journal," June 8, 1872, p. 626. (Infusion.)		

31. SOLANACEÆ.

Atropa Belladonna. (Fig. 35.)

(Deadly Nightshade.)

The deadly nightshade is a native of Britain. It flowers in July, the berries being ripe in September, when they are jet black.

The root is about one or two feet long, creeping, branched, tapering, brownish-white, and bitter.

The leaves are alternate, soft, smooth, and fœtid when bruised. They have short foot-stalks, and are from three to six inches in length. They have been mistaken for ash leaves.

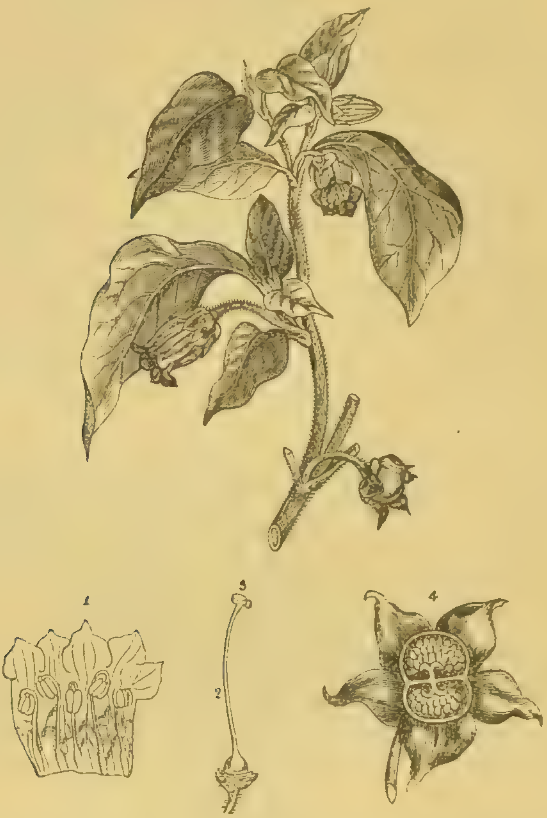
The flowers are of a violet-brown colour.

The berries are about the size of a small cherry, and have a deep central furrow. They are, when ripe, of a shiny black colour, sweet but mawkish, containing several seeds, and a juice which gives a purple stain when dropped on white paper.

The seeds are small and brown (90 to 1 grain: Guy), somewhat oval and honey-combed in appearance when examined with a lens. Under the microscope they will be seen to be studded with projecting specs.

All parts of the plant are poisonous, but more particularly the root, the active principle being the alkaloid *atropia.* Atropia is used in several medicinal preparations, chiefly in the form of a solution of the alkaloid (gr. iv. to ℥j), and as an ointment (gr. viii. to ℥j). Its action is violent. When hypodermically injected, not more than the $\frac{1}{250}$th of a grain should be used. Given internally, Dr. Garrod has seen ill effects from the $\frac{1}{25}$th of a grain. Dr. Garrod has further pointed out that its action is interfered with, if not destroyed, by admixture with the fixed caustic alkalies, but not with the alkaline carbonates, the same being true of other bodies, such as hyoscyamus and stramonium. It is also used for producing dilatation of the pupil, its action in this respect being strictly local; that is, if applied only to one eye, the other eye is not affected. It is also used as an external application to allay pain. It has been suggested that if, in disputed cases of life or death, a minim of a solution of atropine be dropped into the eye it would undoubtedly determine the question.

FIG. 35.



Experiments on Animals.

Dr. Ogle's experiments on the action of belladonna on rabbits are stated in detail in the "Medical Times and Gazette," May 4, 1867, p. 466 (see also "British Medical Journal," Aug. 26, 1865, p. 213). His conclusions are curious. They are,—

1. That a rabbit of middle age can live for six days on belladonna exclusively without inconvenience.

2. That a rabbit can tolerate enormous doses of atropine administered either by the stomach or by subcutaneous injection, this tolerance not being due to non-absorption of the poison.

3. That this tolerance increases with the age of the rabbit.
4. That the dilatation of the pupil is produced just as readily in an old rabbit as in a young one.

Atropia ($C_{17}H_{23}NO_3$).

The alkaloid probably exists in the plant as a malate. About 0·48 per cent. of atropia is found in the root, and the same amount in the leaves (Mr. Luxton). The alkaloid consists of white silky, odourless, four-sided crystals, having a bitter acrid taste.

Atropia is soluble in about 400 parts of cold water, the solution having an alkaline reaction. It is soluble in almost any proportion in alcohol, ether, chloroform, or benzole. It is also very soluble in dilute acids, salts being thereby formed ; from which solutions the alkaloid may be separated in a crystalline form. When heated upon porcelain, it melts at 65·5 C. (150° F.), and sublimes at 137·7 C. (280° F.), at which temperature it may be entirely dissipated. Heated with the fixed alkalies, ammonia is evolved. It is dissolved by the mineral acids, but without change of colour. On addition, however, to the sulphuric acid solution of a crystal of bichromate of potash the mixture acquires a green colour from the production of peroxide of chromium. It gives no precipitate with sulphocyanide or with chromate of potassium, as happens with strychnia.

Symptoms, Dose, &c.

The symptoms produced by belladonna and atropine are identical, except that with the latter they commence sooner and are more severe. With belladonna they usually set in, after from one and a half to two hours, but they have commenced as soon as twenty minutes, and been delayed for five hours. They are not likely to be mistaken for the action of other poisons, except hyoscyamus or stramonium, with which in their general characters they are closely allied.

The patient complains of feeling giddy and drowsy, of great thirst, of dryness in the mouth and throat from suppression of the saliva, and of difficulty in swallowing. Vomiting is an occasional symptom, but purging is rare, although in one case bloody stools are recorded. The pulse is preternaturally strong and rapid, the action of the heart being increased in power. The countenance is flushed, the eyes prominent and sparkling, with possibly some conjunctival congestion, and as a never-absent symptom there is wide dilatation of the pupils. In one case they are reported to have contracted during sleep, but to have immediately dilated again upon waking. Even for some time after the recovery of the patient, the pupils will retain their dilated condition. Early in the case, a loss of speech, with at the same time a constant motion of the lips and tongue, as if attempting to speak, will be manifest. Perhaps, too, there may be loss of vision, or, at any rate, an imperfect, indistinct or double vision, the patient catching at objects within a few inches of him as if they were yards away, a symptom arising not so much from retinal insensibility (which may exist) as from a want of adjusting power. Generally there will be a great desire to micturate, but an inability to do so. Numbness of the extremities, with even perhaps partial paralysis, a desire to walk but an inability to do so, staggering as if drunk, are symptoms gradually leading on to a period of delirium, which is of almost invariable occurrence. The delirium is sometimes maniacal, but more often of a pleasing character, the patient laughing uproariously. Objects appear double, or as if hidden by a cloud, and all forms of hallucinations, spectral illusions, false images, &c., develop themselves. This stage of delirium may precede or succeed a stage of coma, or it may alternate with it, or terminate in it, and lead on to death. But this is not usual, for fatal cases of belladonna poisoning are comparatively rare. The patient after a time falls into a deep sleep, from which he wakes up better, and utterly unconscious of all and everything that has occurred. Other symptoms have been recorded : such as trismus, sneezing, suppression or an involuntary discharge of urine, with hæmaturia, and in several cases a red eruption resembling a scarlatinal rash. In one case, where the poison was taken by a pregnant woman, no action of the poison on the uterus was observed.

Death, when it occurs, usually takes place within fifteen or sixteen hours, but, as we have said, it is not usual for the poison to prove fatal. The patient, however, suffers more or less for a long time, and perhaps permanently, with difficulty of vision and with various other nervous affections. In this respect the action of belladonna is very different to the action of opium. In one case death after seven days is recorded.

Death has been caused by a few ripe berries, by a decoction of 80 grains of the root used as an injection, and by a dram of the extract. Bad symptoms have been produced by two of the berries, and by 3 grains of the extract. Recovery is recorded after the ingestion of large quantities of the berries (in one case as many as fifty), after an infusion of 2 drams of the leaves, and after large doses of the extract, such as 2 and even 3 drams. On the other hand death has resulted from the external application of a belladonna plaster to a sensitive surface. Two grains of atropine has caused death, whilst recovery is recorded after 0·5, 0·6, 1·0, and 1·5 grains. The application of an atropine ointment has also proved fatal.

The activity of the drug is said to be largely influenced by its admixture with strychnia ("Edin. Medical Journal," Sept., 1873).

Treatment.

The treatment in cases of poisoning by belladonna or by its alkaloid, must consist, in the first instance, in the administration of emetics. Animal charcoal, tannic acid, iodine in iodide of potassium, have been recommended; but if they be administered, the stomach pump should afterwards be employed, in order thoroughly to clear the stomach. The assertion that opium was the chemical antidote for the poison is scarcely borne out by experiment. Opium, it is true, produces contraction of the pupils, whilst belladonna produces dilatation. But this is about the extent of their antagonism. As a *chemical antidote* it must not be trusted to, although there is no doubt it is useful in the stage of delirium. It is best administered hypodermically ($\frac{1}{5}$th of a grain of morphia), and may be used to keep the patient in a state of rest ("British Medical Journal," July 20, 1872, p. 82). When the patient is a little better a good dose of castor oil and strong coffee may be given with advantage.

Post-mortem Appearances.

The post-mortem appearances are, as a rule, not well marked. The brilliant eye and the dilated pupils are the chief points to be noted. The brain is usually congested. The stomach may or may not be inflamed. The seeds of the berries must always be carefully looked for, and also any possible staining of the tissues by the action of the juice.

Tests for Atropia.

1. The *fixed caustic alkalies* give with strong solutions a white and at first an amorphous precipitate, which ultimately becomes crystalline, and is insoluble in excess of the precipitant, or in strong acids.

Ammonia gives a similar precipitate, but the precipitate is soluble in very slight excess of the alkali.

2. A *solution of hydrobromic acid saturated with free bromine* gives a yellow precipitate, speedily becoming crystalline, insoluble in either acetic acid, or in the mineral acids, or in caustic alkalies.

3. A *solution of iodine in iodide of potassium* gives a reddish-brown precipitate, insoluble in potash or in acetic acid.

4. *Chloride of gold* gives a citron yellow precipitate, insoluble in potash, and sparingly soluble in acids.

5. *Carbazotic acid* gives a yellow crystalline precipitate, soluble in acids.

6. *Tannic acid* gives a white amorphous precipitate, soluble in caustic alkalies and in acids.

Toxicological Analysis.

In conducting a toxicological inquiry, first of all endeavour to discover any seeds or leaves of the plant, which from their indigestibility, it is probable you may, if death has been caused by them. The vomit and the stools should also similarly, in such cases, be carefully searched, and no better evidence can possibly be afforded of the cause of death, if such be found. Again, the stomach will often be noticed to be stained with the peculiar colour of the fluid of the berries, if these have been swallowed, which colour is turned green by alkalies, and red by acids.

The alkaloid may be separated in the manner already indicated (page 281.) (See also process by Dr. Calvert, "Medical Times and Gazette," May 25, 1872).

The physiological tests are of the greatest importance, and the action of the residue when dropped into the eye, or injected under the skin of a rabbit, should always be noted.

Dr. Harley has found the poison in the urine of animals to which it has been administered. The urine dropped into the eye of another rabbit at once caused dilatation of the pupil. Henbane and stramonium would to an extent, of course, although in a lesser degree, produce a similar result.

Cases of Poisoning by Belladonna.

<table>
<tr><td colspan="3">1.
"Medical Times," Aug. 24, 1844, p. 427. Male: æt. five. Ate a few ripe berries.</td></tr>
<tr><td>*Symptoms.* — Vomiting, convulsions, dilated pupils, mouth spasmodically closed.</td><td>*Result.*—Death in a few hours.</td><td>*Post-mortem.*—Membranes of the brain distended with thick black blood; red spots around the pharynx and œsophagus.</td></tr>
<tr><td colspan="3">2.
"Medical Times," Aug. 24, 1844, p. 427. Male: æt. 34. A great quantity, at least 50, of the berries.</td></tr>
<tr><td>*Symptoms.* — Giddiness, delirium, swollen face, pupils dilated, insensibility. (Recovery after bleeding and emetics.)</td><td>*Result.*—Recovery.</td><td></td></tr>
<tr><td colspan="3">3.
"Medical Times," Sep. 13, 1865, p. 471. Two cases. (1) Female: æt. eight. (2) Female: æt. five. Ate some berries.</td></tr>
<tr><td>*Symptoms.*—In 4 hours became stupified; pupils dilated; loss of speech. (Emetics administered.)</td><td>*Result.*—Recovery.</td><td></td></tr>
<tr><td colspan="3">4.
"Lancet," Aug. 29, 1846, p. 251. Two cases. Male: adult. Male: æt. three. Berries sold for nettleberries and baked in a pie.</td></tr>
<tr><td>*Symptoms.*—Extreme drowsiness, dilated pupils; at last insensibility, and death in violent convulsions. Several other persons also affected.</td><td>*Result.*—Death.</td><td></td></tr>
<tr><td colspan="3">5.
Orfila's "Toxicologie," 1852, vol. ii., p. 478.</td></tr>
<tr><td>*Symptoms.*—150 French soldiers ate the berries. They nearly all had delirium, but recovered the next day, not remembering what had happened.</td><td>*Result.*—Recovery.</td><td></td></tr>
<tr><td colspan="3">6.
"New York Journal of Medical Science," vol. viii., p. 284. Two cases. Male: adult. Male: child.</td></tr>
<tr><td>*Symptoms.*—Ate a pie made of the berries; drowsiness soon came on; and at last delirium and death by coma.</td><td>*Result.* — Child died same day; man died next day.</td><td></td></tr>
<tr><td colspan="3">7.*
"Medical Times and Gazette," Dec. 3, 1859, p. 551 (Dr. Seaton). Male: æt. 23. Ten berries.</td></tr>
<tr><td>*Symptoms.*—In ¾ hour there was dryness of throat, and indistinct vision; delirium; pupils very dilated when awake, but contracted during sleep.</td><td>*Result.*—Recovery.</td><td></td></tr>
<tr><td colspan="3">8.*
"Medical Times and Gazette," Dec. 3, 1859, p. 551 (Dr. Seaton). Male: æt. 23. Five berries.</td></tr>
<tr><td>*Symptoms.*—Dryness of throat, and inability to walk after 3 hours; pupils dilated; no delirium.</td><td>*Result.*—Recovery.</td><td></td></tr>
<tr><td colspan="3">9.*
"Medical Times and Gazette," Dec. 3, 1859, p. 551 (Dr. Seaton). Male: æt. 25. Eight berries.</td></tr>
<tr><td>*Symptoms.*—Symptoms set in after one hour; no delirium.</td><td>*Result.*—Recovery.</td><td></td></tr>
<tr><td colspan="3">* In the above cases opium was used as the antidote.</td></tr>
</table>

10.*

"Medical Times and Gazette," Dec. 3, 1859, p. 551 (Dr. Seaton). Male: æt. 22. Eighteen berries.

Symptoms.—Symptoms set in after 1¼ hours; but they were not severe.	*Result.*—Recovery.	

11.*

"Medical Times and Gazette," Dec. 3, 1859, p. 551 (Dr. Seaton). Male: æt. seven. Six berries.

Symptoms.—Symptoms set in after 1½ hours; vomiting; delirium; pupils contracted during sleep.	*Result.*—Recovery.	

12.*

"Medical Times and Gazette," Dec. 3, 1859, p. 551 (Dr. Seaton). Male: æt. 14. Two berries.

Symptoms.—Symptoms set in after 1 hour; no vomiting, but violent delirium; symptoms as before.	*Result.*—Recovery.	

13.*

"Medical Times and Gazette," Dec. 3, 1859, p. 551 (Dr. Seaton). Female: æt. 46. Twelve berries.

Symptoms.—Symptoms set in after 1 hour; delirium.	*Result.*—Recovery.	

14.*

"Medical Times and Gazette," Dec. 3, 1859, p. 551 (Dr. Seaton). Male: æt. eight. Five berries.

Symptoms.—Delirium; after producing sleep by opium, he woke up much better.	*Result.*—Recovery.	

15.*

"Medical Times and Gazette," Dec. 3, 1859, p. 551 (Dr. Seaton). Male: æt. 12. Two berries.

Symptoms.—Symptoms as usual.	*Result.*—Recovery.	

16.*

"Medical Times and Gazette," Dec. 3, 1859, p. 551 (Dr. Seaton). Female: æt. 14. (?)

Symptoms.—Symptoms as usual. Delirium, with periods of complete unconsciousness.	*Result.*—Death in 29 hours.	*Post-mortem.*—Heart pale and flabby; brain normal; blood fluid; mucous membrane of stomach pale.

17.

"British Medical Journal," Sep. 21, 1861, p. 305 (Dr. Evans). Female: æt. nine. Some berries (about four).

Symptoms.—Throat dry; dilated pupils; bad symptoms did not set in for 5 hours; severe and long-continued delirium, but no coma; sneezing; scarlet rash; great desire to pass water. (Opium given.)	*Result.*—Recovery.	

18.

"British Medical Journal," Oct. 4, 1862, p. 372. Several children ate berries gathered in the Cambridge University Botanical Gardens.

Symptoms.—Symptoms very severe; dryness of mouth; pupils dilated; loss of sensation; delirium; stupor.	*Result.*—Recovery.	

* In the above cases opium was used as the antidote.

19.

Taylor's "Medical Jurisprudence," p. 432. Male: æt. five. A quantity of berries.

Symptoms.—Vomiting; convulsions.	*Result.*—Death in 15 hours.	*Post-mortem.*—Eyes brilliant; dilated pupils; numerous bloody spots found in the brain; redness of the throat, gullet, and stomach.

20.

Taylor's "Medical Jurisprudence," vol. i., p. 430. (Several other cases took place the same year.) Male: æt. 14. Ate 30 berries.

Symptoms. — In 3 hours the symptoms came on; heat and dryness of the throat; extreme giddiness, as if intoxicated; loss of speech; pupils dilated, and eyes insensible to light. On the second day passed some belladonna seeds by the bowels.	*Result.*—Recovered in a week.	

21.

Casper's "Wochenschrift," Feb. 8, 1845. Female: æt. 27. A decoction of ℈iv of the root used as an injection.

Symptoms. — Delirium; afterwards coma; pupils dilated.	*Result.*—Death in 5 hours.	

22.

"Annales d' Hygiène," Oct. 1847, p. 413. Male. ʒij of leaves taken as an infusion.

Symptoms. — Difficulty of swallowing came on in an hour; suppression of saliva; delirium; constant desire to move, but staggered in doing so. Convulsive twitchings; no vomiting or purging.	*Result.*—Recovery.	

23.

Taylor's "Medical Jurisprudence," vol. i., p. 431. Two persons swallowed extract of belladonna instead of juniper.

Symptoms.—Ordinary symptoms set in very soon.	*Result.* — One recovered soon; the other recovered for a time, but died on 7th day.	

24.

Taylor's "Medical Jurisprudence," vol. i., p. 432. Female: æt. (?). Injection of ʒj of extract of belladonna, and ʒj of vin. opii.

Symptoms. — Pupils dilated. The symptoms were not in the least degree influenced by the opium.	*Result.*—Recovery.	

25.

Taylor's "Medical Jurisprudence," vol. i., p. 432. Female: æt. (?) ʒiij of extract in a liniment, given by mistake.

Symptoms.—Slight vomiting; delirium; dilated pupils; loss of speech; paralysis of extremities.	*Result.*—Recovered in 5 weeks.	

26.

"Lancet," 1860, vol. i., p. 133. Male. ʒj of extract.

Symptoms.—Delirium; imperfect sight; dilated pupils.	*Result.*—Recovery.	

27.

"New York Journal of Medicine," Sept. 1845, p. 182, "Lancet," Nov. 29, 1845 (Dr. Gray). Æt. two. Eight to twelve grains of the extract.

Symptoms.—Symptoms came on in half an hour; pupils widely dilated; a scarlet eruption made its appearance; delirium: no well-marked convulsions.	*Result.*—Recovery.	

28.

"Lancet," Feb. 2, 1839, p. 709. Forty grains of extract.

Symptoms.—First coma; and after six hours, delirium. The pulse fell from 160 to 58.	*Result.*—Recovery.	

29.

"Lancet," Aug. 28, 1869, p. 327 (Mr. Molyneux). Male: æt. 16. ʒij of extract.

Symptoms.—Convulsions occurred in 10 minutes; perfect insensibility and death.	*Result.*—Death in 3½ hours.	*Post-mortem.* — Lungs gorged with blood; stomach congested and softened; brain and membranes normal.

30.

"Lancet," Feb. 25, 1854, p. 212 (Dr. Ryan). Female: adult. Three grains of extract.

Symptoms.—In 5 hours she was unable to move her eyelids; dryness of throat; twitchings of legs; dimness of vision.	*Result.*—Recovery.	

31.

"Lancet," Dec. 1, 1849 (Mr. Iliff). Male: adult. Nine grains of extract taken by mistake for taraxacum.

Symptoms.—In 1½ hour a want of power to masticate set in; giddiness; dilated pupils; perfect consciousness.	*Result.*—Recovery.	

32.

"Medical Times and Gazette," Aug. 30, 1851, p. 234. Female: æt. 41. Liniment—containing gr xv of extract of belladonna.

Symptoms.—Rapid coma; pupils very dilated; vomiting produced by emetics. It was eight days before the pupils became natural; the eyes were always sensible to light.	*Result.*—Recovery.	

33.

"Lancet," Feb. 3, 1855, p. 121 (Mr. Solly). Male: æt. 60. ℈j of extract of belladonna, given in error.

Symptoms.—An emetic administered after two hours, when very definite symptoms had set in. The symptoms of poisoning soon after this appeared; dryness of throat; all sorts of delusions; dilated pupils; eyes insensible to light and very prominent; muscular power feeble; very drowsy; no eruption of the skin.	*Result.*—Recovery in 24 hours.	

34.

"British Medical Journal," Nov. 18, 1865, p. 541. Female: æt. 22. Extract of belladonna given by mistake for confection of senna (about ʒijss).

Symptoms. — Unconsciousness; countenance suffused: pupils very dilated; at times was maniacal, but the delirium passed into profound coma; vomiting. (Stomach-pump used.)	*Result.*—Recovery.	

35.

"British Medical Journal," Dec. 23, 1865, p. 654 (Dr. Coombs). Male: æt. four. Belladonna lotion containing 20 grains of extract.

Symptoms. – Face flushed; body in constant motion; sickness.	*Result.*—Recovery.	

36.

"Medical Times and Gazette," March 1, 1862, p. 224. Child. Thirty-five grains of extract of belladonna.

Symptoms. —Ordinary symptoms soon set in; stupor, ending in complete coma. In 22 hours the pupils began to contract a little.	*Result.*—Recovery.	

37.

"British Medical Journal," Sep. 16, 1871, p. 326 (Mr. Mash). Female: æt. 38. A teaspoonful of extract of belladonna.

Symptoms.—No delirium or diplopia; (emetics administered in half an hour); unconsciousness; eliminative treatment adopted.	*Result.*—Recovery.	

38.

"Medical Times," Sep. 16, 1848, p. 322 (Mr. Jackson, of Sheffield). Male: æt. 75. Some of the extract.

Symptoms.—Soon lost power of articulation; paralysis; at last became insensible. No active delirium; face red, and much swollen; extreme exhaustion.	*Result.*—Death in 17 hours.	*Post-mortem.*—Venous system of brain greatly distended; lungs congested; heart natural; stomach black (some doubt whether belladonna could be smelt), the other part of the intestines healthy.

39.

"British Medical Journal," Nov. 20, 1869, p. 555 (Dr. Taylor). Male: æt. 16. ʒj. of extract.

Symptoms.—In 1 hour became violently agitated, unconsciousness; coma, lasting until death. No vomiting, purging, or passing of water.	*Result.*—Death in 2¾ hours.	*Post-mortem.* — Lungs gorged; heart healthy and empty, except the right auricle; stomach fragile, soft dark patches being found internally; brain and membranes healthy.

40.

"Medical Times and Gazette," Nov. 3, 1866, p. 473 (Mr. Wickham Legg). Male: æt. five. A mixture containing 5·5 grs. of extract of belladonna and 36m. of tr. opii., taken for mint sauce.

Symptoms. — Drowsiness; pupils dilated; staggering gait; dry tongue.	*Result.*—Recovery.	

41.

"Lancet," 1870, vol. ii., p. 83. Female: æt. 66. ʒj of belladonna liniment.

Symptoms.—Usual symptoms.	*Result.*—Death in 16 hours.	*Post-mortem.* — Lungs full of blood; brain slightly congested; pupils dilated; viscera otherwise normal.

42.

"Medical Times and Gazette," Oct. 8, 1864, p. 385 (Dr. Woodman). Female: æt. 21. ℥ss of belladonna liniment. (Extract of belladonna rubbed down with water.)

Symptoms.—In 1 hour the face and neck became scarlet; face hot, and limbs cold; pupils immensely dilated. No delirium, but a great tendency to syncope; (emetics, laudanum, and brandy given. The opium contracted the pupils; Calabar bean was afterwards used to remedy the further dilatation.)	*Result.*—Recovery.	

43.

"British Medical Journal," May 20, 1871, p. 533 (Dr. Oxley). Female: æt. seven. A teaspoonful of belladonna liniment (℥j contained ʒj of powdered belladonna root).

Symptoms.—Violent delirium; catching at imaginary objects; pupils dilated; conjunctivæ congested; speech indistinct. (Opium administered.)	*Result.*—Recovery.	

44.

"British Medical Journal," Dec. 25, 1869, p. 684. Female: æt. 48. Belladonna liniment.

Symptoms.—Giddiness in 20 minutes.	*Result.*—Death in 5 hours.	

45.

"British Medical Journal," May 18, 1872, p. 521. Male. ʒij liq. belladonnæ in two ounces of lin. saponis, applied externally.

Symptoms. — Violent symptoms; delirium.	*Result.*—Recovery.	

46.

"British Medical Journal," May 18, 1872, p. 521. Female. Belladonna lotion applied to the breast.

Symptoms.—Extreme restlessness.	*Result.*—Recovery.	

47.

"Medical Times and Gazette," Nov. 22, 1856, p. 513 (Sir Wm. Jenner). Male. Belladonna plaster applied to the back, where another plaster had been previously applied, and a crop of pustules produced.

Symptoms.—In 1½ hours after the application of the second plaster, the tongue and mouth became so dry as to impede articulation; a great desire to pass water. In 5 or 6 hours the mind began to ramble, and there were convulsive twitchings of the limbs and face; limbs lost their power: restlessness; constant catching at objects; pupils very dilated.	*Result.*—Recovery.	

48.

"British Medical Journal," May 18, 1872, p. 520 (Dr. Harrison). Female. A belladonna plaster applied afresh to an abraded surface, from which it had been previously removed.

Symptoms.—Confusion of mind, as if intoxicated; confusion of sight; speech affected; soreness and dryness of throat: delirium.	*Result.*—Recovery.	

ATROPINE.

49.

"American Journal of Medical Science," July, 1866, p. 269. Male: adult. 0·25 gr.

Symptoms. — Frightful delirium occurred in 1 hour; constant motion of lips and tongue; pupils dilated; eyes insensible; constant desire, but no power to micturate. (The delirium was subdued by injections of morphia.)	*Result.*—Recovery in 24 hours.	

50.

Wharton and Stillé's "Medical Jurisprudence," p. 639. Female: adult. ⅔ gr.

Symptoms.—Violent symptoms.	*Result.*—Recovery in 7 days.	

51.

"American Journal of Medical Science," April, 1866, p. 434. Female: adult. $\frac{1}{6}$th gr. injected under skin for facial neuralgia.

Symptoms.—Alarming symptoms; delirium; pupils dilated.	*Result.*—Recovery in [illegible] hours.	

52.

"American Journal of Medical Science," April, 1865, p. 541. Male: adult. Used as an ointment for a blistered surface.

Symptoms.—Violent symptoms.	*Result.*—Death in 2 hours.	

53.

"Medical Times and Gazette," Dec. 17, 1859, p. 601 (Mr. Holthouse). Male: æt. 3½. ʒij of a solution of atropine (gr ij ad ℥j).

Symptoms.—Became almost maniacal, but unconscious; grasped at imaginary objects; pupils very dilated. A little of the vomit from the child fell into the eye of a bystander, and caused dilatation. In 3 hours the child became slightly conscious. Recovery. Pupils were not normal for a week; atropine found in the urine, fæces, and vomit.	*Result.*—Recovery.	

54.

"Berliner Klin. Wochenschr.," 17 April, 1865. Female: æt. 25. One grain of sulphate of atropine.

Symptoms.—Loss of consciousness; twitchings in 1 hour; convulsions; pupils largely dilated; symptoms severe.	*Result.*—Recovery.	

55.

"British Medical Journal," Dec. 23, 1865, p. 654 (Dr. Coombs). Male: æt. three. Atropine lotion (?).

Symptoms.—Flushed face; dilated pupils; grasped at things, but missed their position.	*Result.*—Recovery.	

56.

"Medical Times and Gazette," Feb. 9, 1861, p. 154 (Mr. Roux). Female: æt. 30. 1·5 gr. in solution.

Symptoms.—Pupils very dilated; sight nearly lost; tendency to sleep; cramps; tingling of the extremities; delirium came on afterwards; frequent desire to pass water; did not abort, although pregnant; atropine found in the urine.	*Result.*—Recovery.	

57.

"Lancet," Jan. 2, 1864, p. [illegible] (Dr. Chambers). Male: æt. four. About 0·5 gr.

Symptoms.—In about 2 hours the child began to be unsteady in its gait; constant catching at the air; caught at things close to his reach with his arms extended; pupils very dilated; tetanic spasms in legs. After a sound sleep was much better; pupils continued dilated for some time.	*Result.*—Recovery.	

58.

"Medical Times and Gazette," July 8, 1865, p. 34 (Mr. Leach). Male. One grain of the sulphate in solution.

Symptoms.—Pupils very dilated; seemed intoxicated; no profound coma; became very irritable and obstinate; partial paralysis.	*Result.*—Recovery.	

59.

"British Medical Journal," Dec. 25, 1869, p. 675 (Dr. Parsons). Male: æt. 45. ʒij of an opthalmic solution.

Symptoms.—Dilated pupils; dryness of throat; choking and burning pain; dizziness; "could not feel his legs;" difficult articulation; great restlessness. His hair became quite white.	*Result.*—Recovery in 48 hours.	

60.

"British Medical Journal," July 26, 1873, p. 101. Male. Atropia and alcohol.

Symptoms.—Unconsciousness; dilated pupils; no paralysis.	*Result.*—Recovery.	

61.

Taylor's "Medical Jurisprudence," p. 433 (Mr. Sells). Male: adult. Gr ij of atropia taken on going to bed.

	Result.—Found dead at 7 a.m.	*Post-mortem.*—Pupils dilated; stomach red; no trace of poison was found on analysis.

See also the following Cases:—

BELLADONNA.

"Medical Times and Gazette," May 6, 1865, p. 479. (Injurious effects from external application.)
"Medical Times," Aug. 8, 1846, p. 362.
"British Medical Journal," Dec. 12, 1863, p. 648.
"British Medical Journal," Nov. 24, and Dec. 1, 1866, pp. 596 and 621. (Three cases of poisoning by external use of belladonna.)
"Edinburgh Medical and Surgical Journal," vol. xxix., p. 452.
"Medical Times and Gazette," 1870, vol. i., p. 564.

ATROPINE.

"British Medical Journal," May 14, 1870, p. 489. (Hypodermic injection. Scarlet rash.)
"Medical Times and Gazette," Aug. 27, 1864, p. 238. (One eighth of a grain. Æt. three. Recovery.)
"Medical Times and Gazette," May 25, 1872.
"British Medical Journal," Jan. 21, 1865, p. 68. (Atropine ointment applied after a blister. 15 parts of sulphate to 700 of lard. Death in two hours.)
"British Medical Journal," Aug. 26, 1865, p. 213. (Ashburton poisoning case.)
"Association Medical Journal," Sep. 16, 1853, p. 818.
"Pharmaceutical Journal," May, 1862, p. 583.
"Lancet," March 30, 1872, p. 455.

Capsicum Fastigiatum.

(Cayenne Pepper.)

The dried ripe fruit contains about 4 per cent. of a crystallizable alkaloid (*capsicin*), associated with a resin and a volatile oil. The alkaloid is soluble in water, alcohol, ether, and oils.

Cayenne pepper is an irritant poison.

A case was tried at the C.C.C., 1864 (Reg. *v.* Stevens), where Dr. Letheby found capsicum in the stomach of a child, and was supposed to have caused its death. It had been administered by a quack doctor (a Coffinite). Another case is recorded ("Lancet," July 29, 1871, p. 175) where a quack doctor's pills, containing cayenne, &c., proved poisonous to a woman aged seventy-four (*See* "Lancet," June 22, 1850, p. 766).

Guinea pepper (grains of paradise), it may be remarked, is said to be poisonous, and common black pepper (piperaceæ) has also caused death.

Case of Poisoning by Pepper.

1. "Medical Times," July 1, 1848, p. 139 (Dr. Ritter). Male. A handful of common pepper administered at night in a glass of brandy, for diarrhœa.		
Symptoms.—Pain and vomiting set in in the morning. Collapse and great pain occurred on the second day, and a painful swelling in the right iliac region. On the third day he became worse, and died in the evening.	*Result.*—Death on the third day.	*Post-mortem.*—No post-mortem.

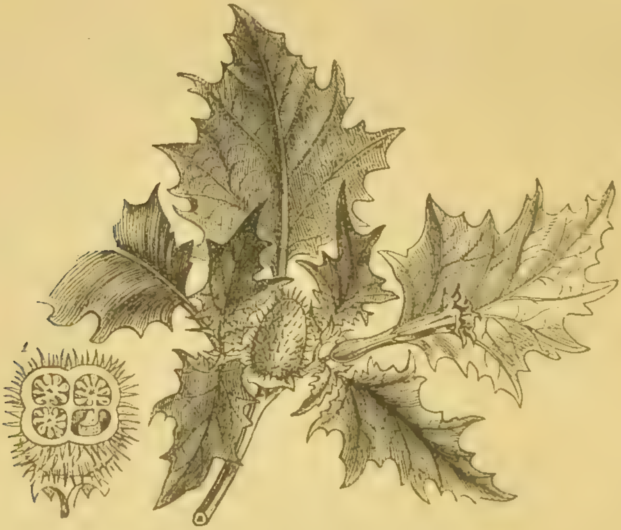
Datura Stramonium. (Fig. 36.)

(Stramonium; Thorn-apple; Jamestown Weed.)

(Found in waste places.)

The leaves are ovate, of a dull green colour, large and smooth, with irregular edges.

FIG. 36.



The fruit (the thorn-apple) is about the size of a walnut, and has prickly coats.

The seeds (8 to 1 grain: Guy) are of a brownish-black colour, flattened, circular or kidney-shaped, and have a corrugated surface. They are bitter, and without smell unless bruised.

All parts of the plant are poisonous, but specially the fruit and seeds. Even the vapour from the flowers (which is not unpleasant) is said to act injuriously. This poisonous action is due to the presence of the alkaloid *daturia* which exists in the plant as a malate. In all forms and however applied, the alkaloid acts as a poison; whilst in France and in the East it has often been given to facilitate the commission of other crimes. It has been recommended in medicine (as well as the leaves of the Datura Tatula) for smoking with or without tobacco in cases of asthma. Its action medicinally is very similar to belladonna.

Daturia ($C_{17} H_{23} NO$).

The plant contains about 1·0 per cent. of the alkaloid. Daturia is regarded by many as identical with atropine, for it has the same composition, and its reactions are almost identical. The crystals are quadrangular, and are very bitter and acrid to taste.

Ammonia is given off when it is heated with caustic alkalies. It is partially soluble in water, the solution having an alkaline reaction. It is dissolved by nitric and hydrochloric acids without change, whilst with sulphuric acid a pale rose tint solution is produced.

Symptoms.

The symptoms of stramonium poisoning set in somewhat sooner than those of hyoscyamus or belladonna, but they are very similar, although somewhat more severe. Ringing in the ears, dryness of the throat, and a flushed face, are early symptoms. The pupils are always widely dilated. Delirium of a violent kind, with spectral illusions, double vision, &c., comes on rapidly, and these usually end in an intense coma. There is often paralysis of the lower extremities, and sometimes irritation of the alimentary canal. A scarlet eruption on the skin has been observed.

Most of the cases in the human subject recover.

Death has been caused in one case in seven hours, and in another in twenty-four.

Experiments on Animals.

These prove that half an ounce of the extract will kill a dog in twenty-four hours: a quarter of an ounce, when applied to a wound, in six hours, whilst twenty grains will prove fatal when injected into a vein. The dilatation of the pupil was in every case well marked.

Treatment.

The treatment to be adopted is the same as for belladonna poisoning. Emetics, the stomach pump, and castor oil, must be chiefly relied upon. In all these cases, if the face is much flushed, the application of a few leeches to the temples is advisable.

Post-mortem Appearances.

The one prominent post-mortem appearance, and the only one worth recording, is the congestion of the brain and of its membranes. It may be noticed that irritation of the stomach has occasionally been found.

Toxicological Analysis.

In conducting a toxicological examination, the finding of parts of the plant in the stomach is at all times the most conclusive evidence.

The alkaloid is very difficult to extract from organic liquids, although it is worth attempting, by a process similar to that already described (page 281).

Cases of Poisoning with Datura Stramonium.

1. "London Medical Gazette," vol. xv., p. 320 (Mr. Duffin). Æt. 2. One hundred seeds.		
Symptoms.—In 1 hour attempted to vomit, and seemed as if intoxicated; pupils dilated; afterwards furious delirium came on, with spectral illusions. In 2½ hours could not swallow from spasms in the throat. Coma, tetanic convulsions, paralysis of bladder, and involuntary stools afterwards occurred.	*Result.*—Death in 24 hours.	*Post-mortem.*—Brain healthy; stomach and intestines normal, but a little redness was noticed in the gullet and larynx; blood semi-coagulated.
2. "Christison," p. 841 (Dr. Droste). Decoction of 125 seeds.		
Symptoms.—Delirium in 15 minutes; coma.	*Result.*—Death in 7 hours.	*Post-mortem.*—Redness in cardiac end of stomach, stomach contained pulpy matters, with remains of seeds; heart empty and brain gorged.
3. "American Medical Times," 1860, vol. i., p. 22 (Dr. Johnson). Male: æt. 7. A quantity of the green seeds.		
Symptoms.—Impaired speech and staggering. In 2½ hours the pupils were dilated, and there was total blindness; the lower extremities became powerless. In 4½ hours there was furious delirium, and afterwards deafness and speechlessness.	*Result.*—Recovery.	
4. "American Journal of Medical Science," July, 1866 (Dr. Evans). Seven children (ages from 6 to 9) each swallowed 10 of the seeds.		
Symptoms.—In all the children, after 4 hours, the pupils were widely dilated. In three, this, with difficulty of vision, was all that was noticed; but in the other four, loss of power in the limbs, with delirium, and afterwards coma set in. All recovered.	*Result.*—Recovery.	
5. "Edinburgh Medical Commentaries," vol. v., p. 163 (Dr. Fowler). Female: child. ʒiss of the seeds.		
Symptoms.—Delirium in 2 hours; spectral illusions; intervals of sleep. A laxative was administered.	*Result.*—Recovery.	
6. "Christison," p. 843. Child. Dose (?).		
Symptoms.—Redness of skin; swelling of abdomen; lockjaw.	*Result.*—Recovery.	

7.

"American Journal of Medical Science," April, 1864. Seven children ate some seeds.

Symptoms.—In 5 there was vomiting, other symptoms being slight. In the other two cases there was no vomiting, but wild delirium manifested itself. They all recovered.	*Result.*—Recovery.	

8.

"American Medical Monthly," Sep. 1856, p. 220. Æt. 4. A tablespoonful of seeds.

Symptoms.—In 7 hours the seeds were brought away by vomiting and purging.	*Result.*—Recovery.	

9.

"American Journal of Medical Science," Jan. 1862, p. 54. Three adults swallowed an alcoholic decoction of stramonium seeds.

Symptoms.—In 2 coma, staggering, and loss of voice occurred; faces became very red, pupils very dilated. In the third, in addition to ordinary symptoms, the skin assumed a scarlet hue. All the cases recovered.	*Result.*—Recovery.	

10.

"Lancet," May 31, 1851, p. 599 (Mr. Laurence). Male: adult. Seeds.

Symptoms.—Insensible to sound; pupils very dilated: drunken stupor, and restlessness. Recovered sensibility in 3 days.	*Result.*—Recovery.	

11.

"Medical Times," (Mr. Stobo). Male: æt. 5. ʒj of the seeds.

Symptoms.—Excitement and delirium in 1 hour; face flushed; pupils dilated; convulsions. No paralysis. (Stomach-pump used.)	*Result.*—Recovery.	

12.

"Christison," p. 843 (Dr. Traill). Male: adult. Gr. xx of the extract by mistake for sarsaparilla.

Symptoms.—Apparent intoxication; incessant talking; dilated pupils. (Vomiting was induced by lemonade, after emetics had failed).	*Result.*—Recovery in 24 hours.	

13.

"Christison," p. 843 (Kaauw Boerhaave). Female: adult. Powder given to procure abortion.

Symptoms.—Convulsions: tetanic spasms, coma.	*Result.*—Recovery.	

14.

"Christison," p. 844 (Rust's Magazine). Decoction of fruit taken in mistake for thistle heads.

Symptoms.—Spasmodic closure of jaws and eyelids; coma. (Blood-letting).	*Result.*—Recovery.	

15.

"Lancet," April 26, 1845, p. 471 (Mr. Spence). Three females took infusion of stramonium instead of horehound.

Symptoms.—Appeared stupid, wild, and unable to speak; pupils dilated, and insensible; conjunctivæ injected; mouth parched. *No vomiting;* breathing stertorous; trembling and convulsive movements of hands; rigidity of the muscles of neck and back. Two cases recovered; the third was fatal.	*Result.*—Two recovered; 1 died.	

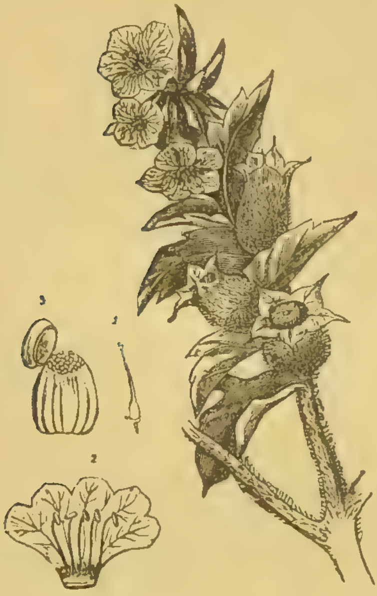
See also the following Cases of Poisoning by Datura Stramonium :—

"Annales de la Société Médico-Chirurgicale de Liége" (M. Kubon). Four cases.
"British Medical Journal," May 19, 1866, p. 523.

Hyoscyamus Niger. (Fig. 37.)

(Hyoscyamus : Henbane.)

FIG. 37.



There are several species of hyoscyamus that are said to be poisonous, as *e.g.*, the *H. Albus* (with which it is reported that a ship's crew was once nearly poisoned); *H. Aureus; H. Physaloides; H. Scopolia,* &c. The H. Niger is the only species, however, of importance. All parts of the plant are poisonous, and may act injuriously even when used merely as a clyster or a poultice. Its energy, however, greatly depends on the time of year at which it is gathered. Its specific action is due to the presence of *hyoscyamia,* probably existing in the plant as a malate, as well as of a peculiar volatile principle, itself an exceedingly active poison, which may be extracted from the plant by weak acetic acid. At present, however, our knowledge of this substance is very imperfect.

The H. Niger is used largely in medicine in the form of a tincture and extract (both of which are prepared from the leaves). It is administered as a sedative to the nervous system.

The plant has a strong unpleasant odour, and a nauseous acrid taste, but both the taste and smell disappear in a great measure when the plant is dried.

The root is spindle-shaped, and has been mistaken both for chicory and parsnips.

The leaves are green, oblong, viscid, hairy, sessile, and surround the stem.

The seeds are somewhat oval, and about the $\frac{1}{18}$th of an inch in diameter, hard, brown, and small, (120 to grain : Guy) having little projections upon their surfaces. They are not unlike the seeds of belladonna.

Hyoscyamia.

Hyoscyamia was first obtained from hyoscyamus by Geiger and Hesse. It has an acrid, tobacco-like taste, and is insoluble in water, but is soluble in alcohol, ether, and chloroform. It is volatilized at a heat a little above that of boiling water. Given internally it acts as a violent poison, and may be found in the urine a very short time after its administration (Dr. Harley).

Symptoms.

The symptoms generally come on somewhat suddenly in from a few minutes to about half an hour after the poison has been swallowed. There is usually at first a little excitement, with giddiness and pains in the head, the face becoming flushed, and the pulse rapid and full. As the case progresses, laborious breathing, incoherence in conversation, or a loss of power to speak will be noticed, whilst the sight becomes either indistinct, or perverted, or absolutely destroyed. In the more advanced state of the case a loss of power in the legs, with shaking of the limbs, and muscular tetanic movements, are common symptoms. Two effects, however, are constant. They are (1) dilated pupils, which may be produced even by the application of hyoscyamus to the eye, and (2) an unmanageable delirium, generally of great violence, alternating with, or ending in coma.

Other occasional symptoms have been noticed, viz , dryness in the throat, vomiting and diarrhœa, and a scarlet eruption of the skin.

Both the seeds and the root have proved poisonous in periods varying from a few hours to some days, but most of the cases recover.

Experiments on Animals.

The experiments on animals prove hyoscyamus to be a pure narcotic poison, having no peculiar local action. When injected into the veins it is far more intense in its effects than when swallowed. The post-mortem appearances that have been noticed are not peculiar. Six drams of the extract proved fatal to a dog in two and a quarter hours, and three drams when applied to a wound on the back destroyed life in four hours.

Treatment.

The treatment to be adopted is the same as that for belladonna (page 410). It has been stated that lemon juice is useful, but it is difficult to see why it should be so.

Post-mortem Appearances.

The post-mortem appearances are negative; except the congestion of the brain and its membranes. Nothing specially to be noted has been observed in the stomach or intestines.

Toxicological Analysis.

In a toxicological examination, the discovery of portions of the leaves or of the seeds must be our main object. The isolation of the alkaloid is next to impossible, but the obtaining a residue which, when applied to the eye of a cat produces dilatation, would be important evidence, and should always be attempted in such cases.

Cases of Poisoning with Hyoscyamus.

<table>
<tr><td colspan="3">1.
"Christison," p. 745 (M. Choquet). Two adults. Two soldiers ate the young shoots dressed as a salad with oil.</td></tr>
<tr><td><i>Symptoms.</i>—Soon became giddy; pupils dilated; the eyes became so insensible that the cornea might be touched without the patient winking; insensibility; paralysis and convulsions. (Emetics given); there was considerable delirium in the course of recovery. They were both well in two days.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">2.
Wilmer on "The Poisonous Vegetables of Great Britain," p. 3. Six adults. Six persons ate the roots by mistake for parsnips.</td></tr>
<tr><td><i>Symptoms.</i> — Delirium in all six cases. One woman had intense coma, and died in the course of 24 hours.</td><td><i>Result.</i>—Death in 24 hours.</td><td></td></tr>
<tr><td colspan="3">3.
"Christison," p. 746 (Wibmer). Female. Hyoscyamus leaves applied as a poultice to the abdomen for strangury and tympanitis.</td></tr>
<tr><td><i>Symptoms.</i>—Stupor; dilated pupils; loss of speech.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">4.
Pyl's "Neues Magazin," vol. ii., 3, p. 100. Two boys ate some seeds.</td></tr>
<tr><td><i>Symptoms.</i>—Both were attacked with convulsions in a few minutes; and one, in whom vomiting could not be induced by emetics, died.</td><td><i>Result.</i>—Death.</td><td></td></tr>
<tr><td colspan="3">5.
"The Lancet," July 5, 1873, p. 8 (Mr. White). Female: æt. 34. ʒxi of the tincture taken in mistake for black draught.</td></tr>
<tr><td><i>Symptoms.</i> — In 10 minutes pricking sensations in the hands and legs were complained of; dryness in throat, giddiness, and delirium. A short time after she found that she could not get out of bed, the power and sensibility of the legs being destroyed; face swollen; purple rash all over the body, lasting more or less for 4 days. In 4 hours became insensible; pupils very dilated; vision very obscure; in 12 hours sickness and delirium; in 28 hours she was relieved, but troubled by seeing imaginary objects. Recovered. Acquired use of legs in 6 days; but for a long time the memory was much affected. (Tincture of galls, milk, and effervescent drinks administered).</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
</table>

See also the following Cases of Poisoning by Hyoscyamus:—

"Annales de la Société Médico-Chirurgicale de Liége (Dr. Danielli). (Poisoning by the berries.)

"British Medical Journal," May 19, 1866, p. 522.

"Medical Gazette," vol. 47, p. 640.

Nicotiana Tabacum.

(Tobacco.)

All parts of the plant contain an alkaloid (nicotine) existing in combination with malic and citric acids, as well as a concrete volatile oil called tobacco-camphor or nicotianin. However the tobacco may be taken, whether as an infusion or as a decoction, or by smoking, these principles are considered by some to be present.

The leaves (the part of chief interest) are covered with numerous short glandular hairs. They have very little smell when fresh, but when dried the odour is specially developed.

The enema tabaci (gr. xx of leaves to 8 ozs. of water) is a pharmacopœal preparation.

Nicotine ($C_{10} H_{14} N_2$).

(Nicotia, Nicotina, Nicotylia, Nicolytia.)

This body was examined by Vauquelin in 1809; by Posselt and Reimami in 1828; and by Orligassa and Barratt in 1842.

French samples of tobacco contain about 7 to 8 per cent. of nicotine; Virginia and Kentucky tobacco contain from 6 to 7 per cent.; whilst Havannah tobacco does not contain more than 2 per cent. (Schloesing).

Nicotine is a colourless, transparent volatile liquid alkaloid like conia. It becomes in time of an amber tint, and eventually changes to a resinoid mass. It has a pungent acrid taste, but not an unpleasant odour unless it be very old, when it seriously affects the nose and eyes if applied to them. It produces a greasy green volatile stain when dropped on white filter paper (Conia gives a pink stain). It has a sp. gr. of 1·048, the vapour having a density of 5·607. It distils at 146° C. (295° F.), and boils at 243·3° C. (470° F.), undergoing a slight decomposition if distilled in air, but not when distilled in hydrogen. It burns with a white smoky flame. It is one of the most rapid and deadly poisons known.

It is soluble in water, alcohol, ether, chloroform, turpentine, and in the fixed oils. Both chloroform and ether extract it from its aqueous solutions.

Its solution in water is alkaline, and it has the peculiar odour and taste of the poison.

It forms crystallizable salts with acids. They have no smell, but retain the peculiar taste of the alkaloid. They are generally soluble in alcohol and water, but are insoluble in ether. On the addition of the fixed alkalies the salts are decomposed, when the alkaloid may be taken up either by chloroform or by ether, or if the solution be distilled it will pass over together with ammonia. If the separation of the ammonia from the nicotine be desired, neutralize the alkaline distillate with oxalic acid, evaporate to dryness, and treat the residue with alcohol, which will dissolve the oxalate of nicotine, but not the oxalate of ammonia.

Tests for Nicotine.

1. If exposed to the action of *the vapour of hydrochloric or of nitric acids* slight white fumes are produced, but they are very much less intense than those developed when conia is similarly treated. No crystals whatsoever are formed. The experiment is best performed by inverting a watch-glass, having a drop of acid upon it, over a second watch-glass containing a drop of the alkaloid.

2. Treated directly with *strong hydrochloric acid* distinct crystals will be formed.

3. With *nitric acid* it changes to a thick reddish liquid.

4. With *sulphuric acid* in the cold no change is produced, but if the mixture be heated it becomes brown.

5. *Perchloride of Platinum* (as with ammonia) gives with aqueous solutions a yellowish crystalline precipitate of the double chloride of platinum and nicotine, which is soluble in hydrochloric acid. (No precipitate is produced with conia.)

6. *Corrosive Sublimate* gives a white crystalline precipitate, changing to yellow, soluble in hydrochloric and in acetic acids.

This is a very delicate test: but note—

(*a*) Corrosive sublimate gives a precipitate with most alkaloids, but such precipitate is almost invariably amorphous.
(*β*) The precipitate given with strychnia is crystalline, but it is almost insoluble in acetic acid.

7. *Arsenio-nitrate of silver* gives a yellow precipitate.

(N.B. The reactions of the three last tests with ammonia are identical to those with nicotine. In order to distinguish ammonia from nicotine the odour must be our chief guide).

8. *Tannic acid* gives a white amorphous precipitate. (Tannic acid produces merely a red colour with ammonia.)

9. *Carbazotic acid* gives a yellow precipitate.

10. *Perchloride of gold* gives a yellow amorphous precipitate, insoluble in acetic and hydrochloric acids, but soluble in caustic alkalies.

11. *Iodine in iodide of potassium* gives an amorphous reddish-brown precipitate, soluble in alcohol and in potash. (No precipitate is given with ammonia.)

Experiments on Animals.

The experiments on animals are important, and we have stated them in a tabular form. The whole subject was investigated with great care by a Committee of the Paris Academy of Medicine in 1845. We would note—

1. That the symptoms produced in the herbivora, however the poison be administered, are different and less energetic than those produced in the carnivora.

2. That tobacco has no effect when applied directly to the brain or to the nerves.

3. That the usually observed symptoms are almost immediate disorder of the respiration, loss of muscular power, tremors, vomiting, stupor and convulsions.

4. Mr. Blake holds that tobacco has no direct action, but only an indirect action, on the heart, by obstructing the capillary pulmonic circulation. He states—(1) that laboured respiration precedes cardiac depression; (2) that the forcible action of the heart may return after it has ceased; (3) that its contractility may continue after death. Sir B. Brodie, on the contrary, held that tobacco has a direct action on the heart, through the nervous system.

Dose.	Animal.	How given.	Symptoms.	Result.	Authority
1. ʒvss of rappee.	Dog.	Stomach; gullet tied.	Nausea, giddiness, stupor, and muscular twitching.	Death in 9 hours.	Orfila.
2. ʒij and 15 grs. of rappee.	Dog.	Wound.		Death in 1 hour.	Orfila.
3. 10 grs. in infusion.	?	Mouth.	In 10 seconds laborious breathing came on: in 20 seconds the action of the heart ceased, but afterwards returned, and became excessive; no convulsions, or loss of sensibility.	Recovery.	Blake.
4. 40grs. in infusion.	?	Mouth.	Similar to last case.	Recovery.	Blake.
5. ʒiij in infusion.	?	Mouth.	Similar to last, except that there were convulsions, and that the heart acted for some time after respiration had ceased.	Death in 2 minutes.	Blake.
6. Infusion, 4 oz.	?	Injected into anus.	Heart was paralysed; in the post-mortem the blood in the aorta was found to be arterial.	Death in 10 minutes.	Brodie.
7. ♏ij of nicotine.	Dog.	Injected into jugular vein.		Death in 90 seconds.	Blake.
8. 1 drop of nicotine.	Cat.	Mouth.	Immediate prostration, followed by convulsions.	Death in 78 seconds.	Wormley.
9. 1 drop of nicotine.	Cat.	On tongue.	Extreme prostration in 10 seconds, then convulsions; micturition.	Death in 2½ minutes.	Wormley.
10. 1 drop of nicotine.	Cat.	Mouth.	Loss of power in 12 seconds, then convulsions.	Death in 75 seconds.	Wormley.
11. 1 drop of nicotine.	Rabbit.	Mouth.	Loss of power in 15 seconds; convulsions; opisthotonos; frothy mucus came from the mouth; poison found in the contents of the stomach; in the blood, and in the soft parts of the mouth and throat, but not in the liver, lungs, or heart.	Death in 3½ minutes.	Taylor.

Symptoms, Dose, &c.

Tobacco may be regarded as essentially a powerful sedative.

There is in the first instance giddiness and confusion, with tremblings of the limbs, considerable faintness and depression, anxiety of countenance, and cold sweats. Often there is sickness and sometimes purging, with violent abdominal pains. The pulse gradually becomes very weak, quivering, and almost imperceptible, the breathing more and more difficult, the vision impaired, whilst paralysis more or less complete, and convulsions more or less severe, usher in death.

As to the pupil there is some discrepancy in the records. Taylor says it is dilated; Pereira, contracted; Wharton and Stillé, natural. Our own observations, with one exception, coincide with those of Dr. Taylor.

The symptoms begin quickly, and terminate rapidly. Death has occurred in fifteen minutes with tobacco, and in three minutes with nicotine. An injection containing in one case only half a dram and in a second case a dram of tobacco has proved fatal, as well as the external application of a decoction for a skin disease. Bad symptoms have been produced when tobacco leaves have been applied to ulcers or even to the sound skin. Recovery, on the other hand, is recorded after injections of half an ounce of snuff and an infusion of five leaves.

Treatment.

Vomiting must be produced as soon as possible with emetics, or else the stomach pump should be used, injecting at the same time a quantity of animal charcoal into the stomach. Afterwards allay pain with opium, and preserve power with stimulants.

Post-mortem Appearances.

These are not very characteristic. The stomach is generally found congested, the heart empty, and the vessels of the brain, liver, and lungs engorged with black blood. The blood is usually black and treacly, but liquid. Nicotine should be looked for in the stomach, liver, and lungs.

Smoking.

In all forms tobacco is a poison. Excessive smoking has proved fatal, as in the cases recorded by Gmelin, where two men smoked seventeen and eighteen pipes respectively at one sitting. Mr. Smith of Sheffield records two cases of paralysis of the portio dura caused by hard smoking. Dr. Chapman gives illustrations of dyspepsia and extreme nervous symptoms resulting from it (" Lancet," March 8, 1845, p. 266). No doubt smoking may be valuable from its soothing action when used in moderation, but in excess there can be no question that it will produce a train of miserable symptoms. Even blindness has been stated to have been occasioned by it. (Tobacco Amaurosis). [For further details respecting smoking see " Dobell on Diet," 6th edit., p. 36, and for some account of the effects of tobacco smoke on boys, see Dr. Decaisne, " British Medical Journal," Sept. 26, 1868, p. 341.] What is the active agent in tobacco smoke? Some have regarded it as a product of the decomposition of the nicotine, and not the nicotine itself, the presence of which in smoke has been questioned. Others have imagined that the injurious effects are due to such vapours as sulphide and cyanide of ammonia, which are said to be always present more or less in tobacco smoke (Vogel).

There is considerable doubt, however, whether nicotine is present or not in tobacco smoke. Vohl and Eulenberg failed to find it, even when the tobacco used contained as much as 4 per cent. The gases that were given off, according to their analysis, consisted of oxygen, nitrogen, marsh gas, carbonic acid, and sulphuretted hydrogen, together with various bases, but not a trace of nicotine. They believe that the evil effects of smoking are due to the pyridine (C_5 H_5 N) bases, whilst they consider that some observers have confounded parvoline (C_9 H_{13} N) with nicotine, and thus erroneously asserted the existence of the latter. The physiological action of both parvoline and pyridine, seem to be very similar to that of nicotine (Vrtjlhrsscrft f. Gericht. Med. N. F. xiv. p. 249.)

On the other hand, Heubel of Kiew has come to entirely different conclusions. He asserts :

1. That nicotine is present in tobacco smoke mainly as a salt of the alkaloid, and more especially if the combustion be not over rapid.
2. That nicotine exists in tobacco as a stable salt of the alkaloid.

3. That the nicotine derived from the smoke of a single cigar is sufficient to produce convulsions, paralysis, and death in a frog. (Centralblatt, Oct. 5, 1872.)

Snuff has caused death, as in the case of the French poet Santeuil, who died from its administration by way of joke. The external application of tobacco has proved injurious, whilst even sleeping amongst bales of tobacco leaves has been recorded as having produced symptoms of poisoning.

Action of Tobacco Manufacture on Workpeople.

From a sanitary point of view it is important to note the action of tobacco manufacture upon the workpeople. This was a matter of careful investigation in 1845 by the Paris Academy of Medicine, and the following were the results of the inquiry :—That on the first admission of a workman to the manufactory, certain symptoms, such as headache, nausea, and often diarrhœa are set up, but that these pass away as a rule in from eight to fifteen days. Women suffer more than men. When the work-people get acclimatised they are rarely afterwards troubled, and are said to have a singular immunity from phthisis, intermittent fever, dysentery, scabies, and neuralgia. A peculiar greyish tinge of skin is said to be noticeable in those that have been at work for at least two years. This proves some distinct change to be going on in the system. No nicotine was discovered on analysis either in the urine or in the blood of the workpeople. It was found that the tobacco emanations killed a rose tree that was placed in the workroom.

Lastly, it was noticed that in some cases (but they were quite exceptional) time did not overcome the bad symptoms induced in the first instance.

Toxicological Analysis.

In a toxicological examination, look carefully with a lens for pieces of tobacco, and examine them under the microscope. They are peculiar from the hairs found on them.

The process recommended for recovering conia may be adopted for nicotine (page 446).

The following process also gives satisfactory results :—Digest the organic liquid with water acidulated with acetic acid, filter, and treat the filtrate with acetate of lead. Again filter, and throw down the excess of lead with sulphuretted hydrogen, filtering off the lead sulphide formed. Then treat the filtrate with caustic potash, pour off the clear supernatant liquid, and distil, when a fluid having the odour and re-actions of nicotine will be obtained. The residuum too in the retort probably contains portions of the poison.

Never neglect to try the action of the residues on small birds, or if there is sufficient, on a rabbit.

Cases of Poisoning with Tobacco.

1. Taylor's "Medical Jurisprudence," vol. i., p. 393. Æt. 10 weeks. A piece of tobacco placed in the mouth of an infant whilst it was asleep.		
	Result.—Death on second day.	

2.

"Journal de Chimie Médicale," 1839, p. 329. Female. Decoction of five leaves used as injection.

Symptoms.—Immediate colic and giddiness; nausea and syncope; difficult breathing; slow pulse; dilated pupils; suppressed urine.	*Result.*—Recovery.	

3.

"Edinburgh Medical and Surgical Journal," vol. ix., p. 159. ʒij in 8 ozs. of water, used as injection.

Symptoms.—Convulsions.	*Result.*—Death.	

4.

"Journal de Chimie Médicale," 1839, p. 328 (M. Caillard). Half oz. of snuff.

Symptoms. — Vomiting, incoherence, dilated pupils.	*Result.*—Recovery.	

5.

"Christison," p. 850 (Dr. Ogston). Male: old. (?) Tobacco given in rum and whisky.

Symptoms.—Found after one hour insensible, and soon afterwards died.	*Result.*—Death.	*Post-mortem.* — Blood everywhere fluid; tobacco found in the stomach.

6.

"Christison," p. 849 (Dr. Grahl, of Hamburg). ℥j boiled for 15 minutes in water, and the decoction used as a clyster.

Symptoms.—In 2 minutes vomiting, convulsions, and stertorous breathing set in. Death.	*Result.*—Death in ¾ of an hour.	*Post-mortem.*—Lividity of the back, lips pale, joints flexible; stomach natural, brain natural, heart entirely empty.

7.

"American Journal of Medical Science," Jan. 1865, p. 268. Male: adult. A decoction applied externally for skin disease.

Symptoms.—Usual symptoms. Death.	*Result.*— Death in 3 hours.	

8.

"London Medical Gazette," 1839-40, vol. i., p. 561, "Christison," p. 848. Child. A decoction used for ringworm.

Symptoms.—Giddiness, vomiting, and fainting.	*Result.*—Death.	

9.

"Gazette Méd. de Paris," Nov. 1840, p. 763 (M. Taorgust). Male: æt. 55. ℥ij of tobacco as an injection.

Symptoms. — Stupor, pain: convulsions in 7 or 8 minutes; laborious breathing succeeded, and then coma and death.	*Result.*—Death in 18 minutes.	

10.

Beck's "Medical Jurisprudence," vol. ii., p. 878. Female: adult. Enema used for worms.

Symptoms.—Convulsions. Death.	*Result.*—Death in 15 minutes.	

11.

Stillé's "Materia Medica," vol. ii., p. 298 (Mr. Skae). Male: adult. Took a large mouthful.

Symptoms.— Insensibility, contracted pupils, weak pulse; afterwards convulsions, dilated pupils, vomiting, purging, and death by syncope.	*Result.*—Death.	

12.

Pareira's "Materia Medica," vol. ii., p. 494. Injection of ʒss of tobacco.

	Result.—Death.	

13.

"Christison." ʒj as injection.

	Result.—Death in 35 minutes.	

14.

"Lancet," Nov. 4, 1871, 663 (Dr. Allan). Female: æt. 48. Leaves applied to ulcers on the leg.

Symptoms.—Sickness, cramps, prostration, dimness of vision, and numbness; sleepiness, and irregularity of heart set in on the third day. Recovery in a week.	*Result.*—Recovery.	

15.

Taylor's "Medical Jurisprudence," vol. i., p. 393 (Dr. Nanias). Male. Covered his body with tobacco leaves to defraud revenue.

Symptoms.—Poisonous effects were produced as soon as the perspiration had moistened the leaves.	*Result.*—Recovery.	

NICOTINE.

16.

Orfila's "Toxicologie," vol. ii., p. 498 (case of Count de Bocarmé). Quantity (?) Forcibly administered by the Count and his wife to Gustave Fougnies.

	Result.—Death in 5 minutes.	*Post-mortem.*—Nicotine found in mouth, throat, stomach, liver, and spleen; tongue swollen, epithelium detached; stomach intensely congested, lungs gorged, heart normal, blood not coagulated.

17.

Taylor's "Medical Jurisprudence," vol. i., p. 393. Male: adult. Quantity (?).

Symptoms.—Died in a very short time. No convulsions, but heaved a deep sigh as he expired; seemed to be insensible directly he had taken it.	*Result.*—Death in 3 to 5 minutes.	*Post-mortem.*—Eyes staring; lividity about the neck; membranes of the brain filled with dark-coloured blood; lungs engorged, heart empty, except the left auricle, which contained dark-coloured blood; stomach intensely congested, but had no peculiar odour; liver congested; blood generally black and liquid; nicotine found in the contents of the stomach.

See also the following Cases of Tobacco Poisoning:—

"British Medical Journal," Nov. 1, 1873, p. 520. (Death from chewing tobacco.)
"Lancet," 1866 (?). (Half oz. put into mouth at one time. Death in 3 days. Male: æt. 20.)
"Medical Times and Gazette," Dec. 23, 1865, p. 698. (Death from chewing tobacco.)
" " Nov. 19, 1864, p. 559. (Death from chewing Limerick roll tobacco.)
"Medical Times," Jan. 24, 1845, p. 326. (Bad effects of a tobacco enema in a child, æt. 4½.)

Solanum Dulcamara.

(Woody Nightshade—Bitter Sweet.)

This plant is very common in hedges and on the roadside. It flowers in June. The *flowers* are purple with yellow stamens, and the *berries* are bright red. The *red* berries of the *S. dulcamara* are not so poisonous as the *black* berries of the *S. nigrum.* The active principle of the plant is solanine.

M. Duval (so it is stated) gave 180 berries as well as 4 ozs. of the extract to dogs without their producing any effect. He also cites a case in the human subject where ℥iv of the extract was taken in two doses, but without serious results.

Chevallier records a case where sleep was produced as the result of a person carrying a bundle of the woody nightshade on his head.

The discordant results of these experiments, and the widely different effects that resulted in the cases of poisoning recorded by the drug, are to be explained by the varying activity of the plant at varying seasons and times.

Death is recorded to have been produced by two berries in a child four years old. Vomiting, purging, and convulsions seem to be the ordinary symptoms.

Solanum tuberosum.

(Potato.)

This plant has produced serious effects.

Its active principle is *solanine.*

Solanum nigrum.

(Black or Garden Nightshade.)

This is an annual plant found in gardens. The *flowers* are white and the *berries* black. Its active principle is *solanine.*

The leaves and berries have both proved fatal to children in the course of about twelve hours. The ordinary symptoms produced were pain, dilated pupils, with delirium and convulsions of a tetanic nature.

Other varieties of the Solanum have also proved poisonous, as *e.g.*, the *S. fuscatum*, fifteen berries of which have produced serious effects, and the *S. mammosum.*

The active principle in each case is *solanine.*

Solanine.

(Solania) $C_{43} H_{70} NO_{16}$.

Solanine constitutes the active principle of the preceding plants. It is found as a white or a yellowish white powder, without smell, having a bitter acrid taste, and crystallizing in needle-like tufts.

It is soluble in water (1 in 1750), in benzol (1 in 8400), in ether (1 in 9000), in chloroform (1 in 50,000), and in amylic alcohol (1 in 1060).

It is readily soluble in alcohol as well as in dilute acids, with which it forms salts.

The salts of solanine are soluble in water, but are insoluble in chloroform or ether.

If heated upon porcelain, solanine first discolours, and then fuses (216° C.), when dense white vapours are given off which have an agreeable odour, whilst an abundant carbonaceous deposit is left behind.

Cold sulphuric acid changes it to an orange yellow, and then dissolves it, the solution becoming brown.

Nitric acid dissolves it, the solution being first colourless, and afterwards changing to a rose-red tint.

Hydrochloric acid dissolves it without change of colour.

Heated with dilute sulphuric acid it is changed into grape sugar, a new alkaloid being formed called *solanidine.*

Symptoms, Treatment, &c.

The symptoms produced by the preceding plants and by their alkaloid are thirst, intestinal irritation as evidenced by pain, nausea, vomiting, and purging, and also severe nervous symptoms, such as convulsions, extreme and violent delirium, tetanic cramps, and coma.

We have no record of any special *post-mortem appearances.*

The *treatment* is to get rid of the poison by emetics, and by the stomach pump. Strong tea and coffee are advisable, and it may be necessary to give stimulants freely.

Experiments on Animals.

The experiments made on animals with solanine are few and unsatisfactory. Otto's experiments on rabbits prove that 1 to 3 grains constitutes a poisonous dose. Schroff (Stillé's Mat. Med. i., 763) administered doses varying from the $\frac{1}{30}$th of a grain to 3 grains to healthy persons. The pupils were not altered. There was giddiness, a great desire but an inability to sleep, nausea, an irritability of the skin, with difficult breathing and numbness of the legs.

Tests.

1. *Sulphuric acid* gives an orange yellow precipitate, which when dissolved forms a yellow solution, becoming ultimately purple (solanidine).
2. *The alkalies and the alkaline carbonates* give with the salts of solanine a colourless gelatinous precipitate of the alkaloid.
3. *Iodine in iodide of potassium* gives with the salts of solanine an orange brown precipitate, insoluble in dilute acids.
4. *Chromate of potash* gives a yellow precipitate, which is soluble when the liquid is treated with a few drops of sulphuric acid, the solution becoming blue.

Cases of poisoning with the varieties of Solanum.

(I.) SOLANUM DULCAMARA.

1.

"Lancet," June 28, 1856, p. 715. Male : æt. 4. Ate two of the berries.

Symptoms.—In 15 hours purging and vomiting. Convulsions, alternating with coma. Death in convulsions at the end of 32 hours.	*Result.*—Death in 32 hours.	

2.

"Lancet," June 28, 1856, p. 715. Female: æt. 6. Sister of above, ate only one berry.

Symptoms. — Purging and sickness. Recovered.	*Result.*—Recovery.

3.

"Lancet," June 28, 1856, p. 715. Female: æt. 8. Ate two berries.

Symptoms.– No marked symptoms.	*Result.*—Recovery.

4.

Beck's "Medical Jurisprudence," vol. ii., p. 825. Several children ate the berries.

Symptoms.—All suffered severely. In one there was salivation. All recovered.	*Result.*– Recovery.

(II.) SOLANUM NIGRUM.

5.

"Guy," p. 517 (from Tardieu). Two children: æt. 3½ years. Ate the leaves.

Symptoms. — In 1 or 2 hours pain, nausea without vomiting, and delirium, set in. One child died in about 12 hours. The delirium became excessive, with convulsions; dilated pupils; coma. The other child recovered in 24 hours, after severe symptoms. In this case also the pupils were fully dilated.	*Result.*—(1) Death in 12 hours. (2) Recovery.

6.

"Orfila's Toxicologie," 1852, vol. i., p. 313. Three children ate the berries.

Symptoms.—They all had severe symptoms. One child died in 12 hours, with tetanic convulsions. The other two children recovered for a time, but had a relapse, and died. The vomit was green; pupils dilated; convulsions, with tetanic stiffness of the limbs.	*Result.*—Death.

8.

"Medical Gazette," vol. xlvi., p. 548.

(III.) SOLANUM TUBEROSUM.

7.

"British Medical Journal," 1859, p. 719 (Mr. Morris) Female: æt. 14. Ate the berries.

Symptoms.—Jactitation, cold perspirations, skin livid, respiration hurried, pulse quick, teeth closed, but a constant spitting of a thick phlegm; loss of speech; great restlessness. Death on second day.	*Result.*—Death.

9.

"Christison," p. 749; "Journal de Chimie Médicale," 1837, p. 130.

Symptoms.—A family of four had serious narcotic symptoms produced by eating potatoes which had commenced to germinate and shrivel. The father seemed at first intoxicated, then comatose. The mother and 2 children had convulsions and then coma. In all four there was vomiting. Recovered in 2 hours.	*Result.*—Recovery.

32. THYMELACEÆ.

Daphne Mezereum. (Fig. 38.)

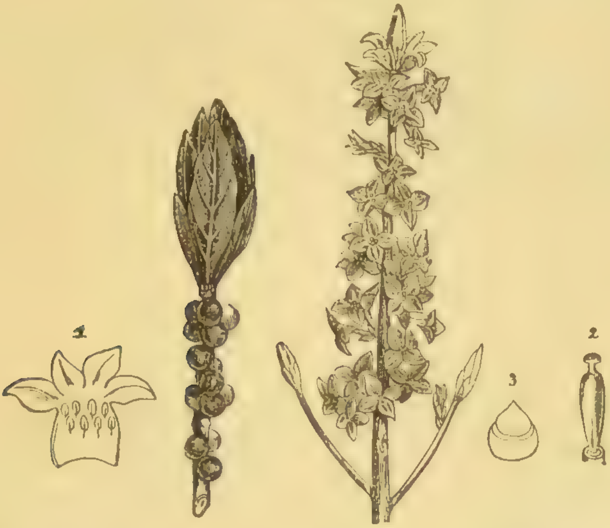
(Mezereon.)

Mezereon is a garden shrub, having bright red berries, each containing a single seed. They are very beautiful, and have been frequently mistaken by children for currants.

It is an active narcotico-acrid poison.

Five or six berries will produce bad effects. Linnæus saw a wolf die from eating six berries, and a girl from taking twelve.

FIG. 38.



The *Daphne Gnidium* (Garon) was examined by Orfila.

Three drams of the powdered bark killed a dog in twelve hours, given by mouth, a ligature being placed on the gullet; and two drams in two days when the powder was applied to a wound.

The *Daphne Laureola* (Spurge-laurel) is also poisonous.

Cases of Poisoning with Mezereon.

1. "Lancet," 1837–38, vol. i., p. 44 (Dr. Grieve). 3 cases. Male: æt. 2. Female: æt. 2½. Female: æt. 3. Berries.		
Symptoms.—Vomiting and purging in a few minutes. In the two younger the symptoms ceased after an emetic. In the eldest narcotism came on, and in 6 hours she was quite comatose; pupils slightly dilated; respiration slow; intermittent pulse; very thirsty when she was roused, but complained of no pain. Stimulants were administered, and in 1 hour she again roused up complaining of great thirst. A dose of calomel was given, and it was noticed that the stools were singularly devoid of bile. Recovered in about 3 hours. Only 1 berry passed by stool.	*Result.*—Recovered.	

2.

"Lancet," Aug. 19, 1837 (Dr. A. T Thompson, quoted from Keat). Mezereon given as a remedy for dropsy.

Symptoms.—Death in 6 weeks, preceded by diarrhœa and vomiting.	*Result.*—Death.	

3.

"Lancet," Dec. 15, 1849, p. 637, and Casper's "Wochenschrift." 2 cases. Male: æt. 4. Female: æt. 2. The berries.

Symptoms.—The eldest child had dryness of the throat and nausea; afterwards narcotism. The little girl had no symptoms at first, but on an emetic being given she vomited eight berries. An hour after this, complete narcotism set in with coma, convulsions, and dilated pupils.	*Result.* — Recovery the following day.	

4.

"Medical Times," Aug. 24, 1844, p. 427. Male: adult. Forty berries.

Symptoms.—Pain; violent vomiting; bloody stools; head giddy; pupils dilated; great thirst; pulse frequent and irregular; urine dark coloured.	*Result.*—?	

33. UMBELLIFERÆ.

Æthusa Cynapium.

(Fool's Parsley, Lesser Hemlock.)

The leaves of the fool's parsley have been eaten by mistake for common parsley, and the roots for parsnips. The plant may be known from true parsley by its producing when rubbed a nauseous odour, by the leaves being of a dark green colour, and glistening on the lower surface, and by the three long drooping leaflets or bracts appended to the flower stalks.

It is a narcotico-irritant poison.

It acts as a poison to animals. Six ounces of the juice introduced into the stomach of a dog, and secured by ligature, killed it in one hour, stupor and convulsions being prominent symptoms.

In the human subject it has caused death in one hour. Nausea, vomiting, stupor, and insensibility, difficulty of swallowing, tremblings in the limbs, dilated pupils, and lock-jaw, have been observed. If early and free vomiting does not occur either spontaneously, or by the aid of emetics, the case is almost certain to end fatally.

The active principle is a body called *Æthusin.*

Cases of Poisoning with Æthusa Cynapium.

1.

"Medical Times," Aug. 23, 1845, p. 408 (Mr. Thomas). Female: æt. 5. Bulbs taken by mistake for turnips.

Symptoms.—Immediate pain, but no vomiting; could not swallow; was incapable of answering questions; expression wild; no convulsions, but the lower jaw became so fixed that nothing could be introduced into the mouth. Death.	*Result.*—Death in 1 hour.	

2.

"Medical Times," Aug. 23, 1845, p. 408 (Mr. Thomas). Female: æt. 3. Bulbs by mistake for turnips.

Symptoms.—Pain, sickness, vomiting, perspiration. Recovered.	*Result.*—Recovery.	

3.

"Medical Times," Aug. 23, 1845, p. 408 (Mr. Thomas). Female: æt. 3. Bulbs by mistake for turnips.

Symptoms.—Symptoms similar to above; early vomiting and recovery.	*Result.*—Recovery.	

4.

"Churchill's Botany" (Mr. Stevenson), "London Medical and Physical Journal," vol. xiv., p. 425. Taken by two ladies in salad.

Symptoms.—Nausea, vomiting, giddiness, inclination to sleep, numbness and trembling of limbs, and difficulty in swallowing.	*Result.*—Recovery.	

5.

"Geschichte der Pflanzengifte," p. 571 (Gmelin). Child.

Symptoms.—Pain in stomach, swelling of abdomen, difficult breathing. Death.	*Result.*—Death in 8 hours.	

Cicuta virosa, or C. aquatica.

(Water Hemlock, Cowbane.)

All parts of this plant are poisonous, but more particularly the root, although there is reason to believe that the plant which grows in England is not so poisonous as that which grows abroad. The roots have been mistaken for parsnips.

Its action upon animals has been studied by Wepfer and Linnæus. It produces tetanus and death, usually on or about the third day.

Symptoms, &c.

The symptoms come on rapidly, and are, first a great giddiness and dryness of the throat. The face will be flushed, and possibly foam be found to issue from the mouth. Vomiting is not unusual, but purging does not often occur. The breathing becomes difficult and spasmodic. The pupils are commonly widely dilated. Convulsions, accompanied by tetanic symptoms, and in one case opisthotonos, passing either into profound coma, or into delirium with various hallucinations, or into a more or less general paralysis, are ordinary symptoms. Several cases are recorded where the root has proved fatal. In one case death is stated to have occurred in thirty minutes, and in another in a few hours.

Cases of Poisoning with Cicuta Virosa.

1.

"Wibmer," p. 119 (Mertzdorff), "Journal Complémentaire," vol. xvii., p. 361. Three children.

Symptoms.—Convulsions and vomiting. Death rapid.	*Result.*—Death rapid.	*Post-mortem.*—Mucous membrane of stomach injected: redness of the air passages and stomach; vessels of brain filled with dark liquid blood; bluish red spots found on the skin.

<table>
<tr><td colspan="3">2.
"Wibmer," p. 119, "Journal Complémentaire," vol. xvii., p. 361 (Wepfer). Male: æt. 20. A large quantity of the root.</td></tr>
<tr><td><i>Symptoms.</i>—Breathing difficult, with foaming at mouth. Epileptic fit, with tetanic stiffness, and spasmodic breathing. Unconsciousness.</td><td><i>Result.</i>—Death.</td><td><i>Post-mortem.</i> — Stomach red, blood fluid.</td></tr>
<tr><td colspan="3">3.
"Lancet," Sep. 16, 1871, p. 396 (Mr. Willson). Male: æt. 48. Cooked root eaten by mistake for parsnips.</td></tr>
<tr><td><i>Symptoms.</i>—Giddiness and dryness of throat in half-an-hour. In 1½ hour there was paralysis of the legs, and loss of power in the arms; face flushed. After an emetic he was able to stand, and then passed a quantity of urine. Hallucinations. After 7 hours dilated pupils; occasional delirium. No purging. Recovered in two days.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">4.
"Pharmaceutical Journal," June, 1872, p. 1063. Two boys. The root eaten by mistake for celery.</td></tr>
<tr><td></td><td><i>Result.</i>—Death.</td><td></td></tr>
<tr><td colspan="3">5.
"Cic. Aquat.," p. 80 and 107 (Wepfer). Eight children ate the roots instead of parsnips.</td></tr>
<tr><td colspan="3">6.
"Cic. Aquat.," p. 80 and 107 (Wepfer). Female: æt. 6.</td></tr>
<tr><td><i>Symptoms.</i>—Tetanic fits. Coma for 24 hours.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">7.
"Cic. Aquat.," p. 80 and 107 (Wepfer). Two cases.</td></tr>
<tr><td><i>Symptoms.</i>—Swelling of stomach; vomiting; insensibility; involuntary discharge of urine; convulsions; lockjaw; opisthotonos. Both died in a little over 30 minutes.</td><td><i>Result.</i>—Death in about 30 minutes.</td><td></td></tr>
<tr><td colspan="3">8.
"Journal de Chimie Médicale," 1842, p. 877. One root between 4; (1) Child, æt. 3; (2) Three other children, the eldest being 6.</td></tr>
<tr><td><i>Symptoms.</i>—(1) Colic; vomiting; convulsions. Death.</td><td><i>Result.</i>—Death in a few hours.</td><td></td></tr>
<tr><td><i>Symptoms.</i>—(2) Coldness; dilated pupils; spasms, and insensibility; intermittent pulse. Recovered after emetics.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
</table>

Conium maculatum. (Fig. 39.)

(Conium, Hemlock, Common or Spotted Hemlock.)

Hemlock is a very common plant, growing in all hedges and wild places. All parts are poisonous, the poisonous action being due to the presence of an alkaloid *Conia*, ($C_8 H_{15} N$), existing in the plant in combination with coniic acid. The alkaloid can easily be set free, and its peculiar odour, said to be "mousy," or like cats' urine (Taylor), may be developed by merely squeezing parts of the plants between the fingers, or better, by rubbing them up with a little caustic potash.

Another substance (Methyl-Conia, $C_2 H_3 N$) is said also to be present (Kekulé, and Von Planta.)

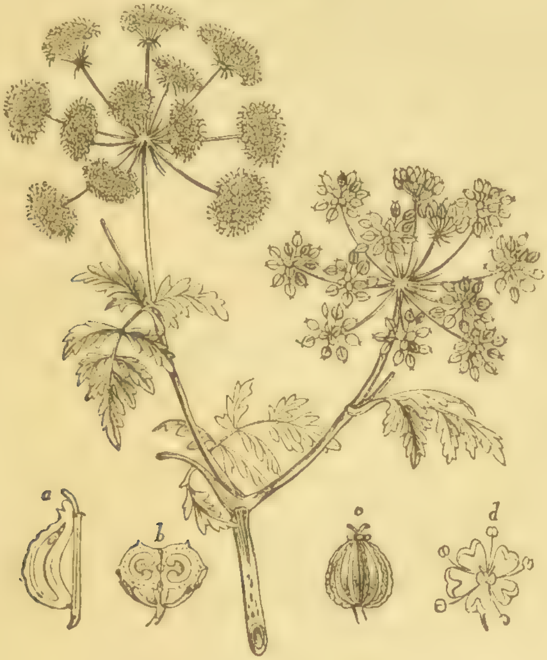
The *root* is tapering, and in shape somewhat like a parsnip, for which it has been mistaken. It is the least active part of the plant.

The *stem* is tall, round, and smooth, of a glossy green colour, and marked with brownish purple spots.

The *leaves* are deep green, tripinnate, and something like parsley leaves, for which they have frequently been mistaken.

The *seeds or fruit* (20 to grain, Guy) "are distinguished from other seeds of the umbelliferæ by the presence of five prominent wavy ridges, and the absence of the linear receptacles for volatile oil, termed vittæ."

FIG. 39.



Hemlock is used in medicine; but all the preparations are more or less uncertain in their action, from the circumstance that the alkaloid is so easily decomposed. The leaves, too, are used as a poultice, mixed with linseed.

The death of Socrates is generally believed to have been due to hemlock, though Sir R. Christison refers it to some other plant of the same order.

Conia ($C_8 H_{15} N$).

(Conein, Conine, Conicine, Conicina, Conylia, Cicutine.)

(Sp. gr. 0·87. Boils at 212° C.)

The alkaloid is most abundant in the fruit of the plant. One ounce may be obtained from six pounds of the *fresh* unripe fruit, and a similar quantity from nine pounds of the *dry* ripe fruit.

Conia and nicotine are the only two alkoloids that are liquid at ordinary temperatures. When pure, conia is colourless, oily, and volatile, but if kept for a time it turns yellow, and afterwards becomes dark coloured, being resolved, by decomposition, into a brown resinoid matter and ammonia. Its taste is bitter, acrid, and persistent. It boils at 212° C.; but it distils over with the vapour of water, undergoing slight decomposition at 180° C. If distilled in an atmosphere of hydrogen, no such decomposition occurs.

The vapour is inflammable, and burns with a yellow flame, the combustion being accompanied by the evolution of considerable smoke.

It has an exceedingly pungent smell ("mousy"), which can be detected in a drop of water containing not more than the 50,000th part of the alkaloid. It is a violent poison, in whatever way it is administered.

It imparts a greasy volatile stain to blotting-paper. It is very slightly soluble in water (1 in 100), the aqueous solution being alkaline.

It is very soluble in chloroform, alcohol, and ether; all three of which solvents, but especially the last, remove it from its aqueous solution.

It forms salts with acids. The salts are without smell; but the peculiar odour is immediately developed when they are treated with an alkali, from which mixture the alkaloid may be obtained by distillation. They are generally soluble in water and in alcohol, but not in ether. The administration of acids, therefore, in cases of poisoning is not advisable, as the poison is rendered more soluble, and absorption consequently more rapid. Conia yields by oxidation, under certain conditions, butyric acid. For its special chemical reactions with different bodies, see the Tests (p. 445).

The Relation between Conia and Nicotine.

There are several points of close relationship between conia and nicotine. They are both, as we have said, liquid at ordinary temperatures. They have both an intense and peculiar odour, and when their salts or aqueous solutions are distilled with caustic soda or potash, they are to be found in the distillate, giving the liquid an alkaline re-action, in which respect they are also similar to ammonia.

But they cannot well be confused.

Nicotine has:—(1) A tobacco odour; (2) It is freely soluble in water in all proportions; (3) No crystals are formed when it is exposed to the vapour of hydrochloric acid; (4) Corrosive sublimate gives a white precipitate, which in time becomes yellow and crystalline; and (5) Nitrate of silver gives a white precipitate, turning dark on exposure to light.

Conia has:—(1) A "mousy odour;" (2) It is sparingly soluble in water; (3) Crystals are formed when it is treated with, or exposed to the vapour of hydrochloric acid; (4) Corrosive sublimate gives a white amorphous precipitate; and (5) Nitrate of silver gives a dark brown precipitate, changing to black.

Symptoms—Dose, &c.

The hemlock plant begins to act in from a few minutes to half an hour, but the pure alkaloid is far more rapid in its action. Headache, mperfect vision, loss of power to swallow, and extreme drowsiness are irst noticed. The pupils will be seen to be *dilated* and fixed, the pulse eing variable and often intermittent. Gradually complete paralysis of the extremities comes on, commencing with great muscular weakness and loss of power. This paralysis gradually extends to the muscles of respiration, and the patient at last dies by apnœa. Convulsive twitches are not uncommon. Conia does not paralyze the heart, for it is often noticed to beat after death. Its special action is confined to the voluntary muscles, and to the muscles of respiration. The patient will remain conscious until the respiratory muscles become affected. There is seldom much pain, palsy being the prominent symptom.

If death be delayed for a time, then convulsions, coma, and more commonly delirium of a frantic kind, accompanied by salivation and by an involuntary discharge of the urine and fæces may be found.

Christison's view of its action may be correct. It is a local irritant; but its action as an irritant is overwhelmed by its action as a narcotic.

Death usually takes place in from one to three hours. One drop of conia may be regarded as a poisonous dose.

Treatment.

To get rid of the poison is the first indication; and for this, emetics of sulphate of zinc, or mustard, or the use of the stomach-pump, followed by castor oil, is indicated. After this stimulants must be given. Dr. Pareira mentions strychnia as an antidote, from its opposite physiological action. It would be dangerous to try it.

Post-mortem Appearances.

They are those of death by apnœa. The *stomach* is generally found somewhat congested—the *lungs* invariably so—the *intestines* healthy—the *brain* more or less congested, and the *blood* very fluid.

Experiments on Animals.

These are of considerable importance, and we have tabulated them for ease of reference. We would remark

1. That Christison rarely found convulsions a prominent symptom, whilst, on the other hand, Orfila records convulsions as general. No doubt Christison's observations are the more correct.
2. That the root is not a very active part of the plant, and that when gathered at some periods of the year it is almost inert.
3. That Christison records a case of instantaneous death. This does not agree with the experiments of Mr. Blake, who says he never saw it prove fatal in less than fifteen seconds.

The later experiments of M. Verigo, published in the "Centralblatt" (No. 2, 1871), are important. His conclusions are—

1. That conia acts most strongly on the spinal cord.
2. That in *frogs* we get paralysis but no convulsions; but that in mammals convulsions occur after large doses, and paralysis of the extremities, only after small ones.

3. That neither the sensory nerves nor the brain are much affected.
4. That respiration is retarded by small doses of conia, which may effect complete paralysis of the muscles of respiration.
5. That convulsions, when they occur in mammals, is a certain indication of a fatal result.
6. That conia exerts no action on the heart, the blood, or the pulse.
7. That its action on the pupil is not constant.
8. That it lowers the temperature.
9. That it does not influence the quality or quantity of the urine.
10. That the post-mortem appearances are not characteristic.

Experiments with Hemlock and Conia on Animals.

Dose and form of administration.	Animal.	How administered.	Time when symptoms appeared.	Symptoms.	Death, or Recovery.	Authority.
1 oz. extract of leaves.	Dog.	By stomach.	.. ..	Convulsions and insensibility.	Death in 45 minutes.	Orfila.
90 grs. extract of leaves	Dog.	Through wound.	.. ..	Convulsions and insensibility.	Death in 90 minutes.	Orfila.
28 grs. extract of leaves.	Dog.	Injected into vein.	.. ..	Convulsions and insensibility.	Death in 2 minutes.	Orfila.
30 grs. alcoholic extract of green seeds.	Rabbit.	In wound.	.. ..	Palsy—first of voluntary muscles, then of muscles of chest, then of diaphragm; no convulsions; heart contracted vigorously after death for some time.	Death in 5 minutes.	Christison.
30 grs. alcoholic extract of green seeds.	Puppy.	?	.. ..	Palsy—first of voluntary muscles, then of chest, then of diaphragm; no convulsions; heart contracted vigorously after death for some time.	Death in 20 minutes.	Christison.
3 lbs. of the root (gathered in April).	Dog.	Mouth.	.. ..	No effect.	Recovery.	Orfila.
2 lbs. of the root (end of May).	Dog.	Mouth.	.. ..	.. ..	Death in 6 hours.	Orfila.
12 ozs. of juice of root (Nov.).	Dog.	Mouth.	.. ..	No effect.	Recovery.	Christison.
10 ozs. of juice of root (June).	Dog.	Mouth.	.. ..	Diarrhœa only.	Recovery.	Christison.
6 ozs. alcoholic extract of root (June).	Rabbit.	Wound.	.. ..	.. ..	Death in 37 minutes.	Christison.
1 drop of Conia.	Rabbit.	Eye.	.. ..	.. ..	Death in 9 minutes.	Christison.
3 drops of Conia.	Cat.	Mouth.	.. ..	.. ..	Death in 1½ minutes.	Christison.
5 drops of Conia.	Dog.	Mouth.	30 seconds.	.. ..	Death in 1 minute.	Christison.
2 grs. of Conia neutralised with Hydrochloric acid.	Dog.	Injected into Femoral vein.	Instantaneously.	.. ..	Death instantaneously.	Christison.
1 drop of Conia.	Cat.	Mouth.	Few seconds.	Loss of power to stand after a few seconds; convulsions; passed water.	Death in 3 minutes.	Wormley.
1 drop of Conia.	Cat.	Mouth.	45 seconds.	Could not stand; became insensible; pupils dilated; spasms of extremities; passed urine.	Death in 4 minutes.	Wormley.

Tests for Hemlock and its Alkaloid.

In considering the reactions of conia it is to be noted that none of them are to be regarded as indisputable tests taken alone, but that they must always be taken in conjunction with the peculiar smell, taste, appearance, and physiological action of the poison.

1. (*a*) If the vapour of conia be exposed to the vapour of *hydrochloric acid*, white fumes are immediately produced. The conia will be found solidified to a mass of a *crystalline chloride*, crystals of the salt being also found in the hydrochloric acid. The chloride is a permanent salt.
   (*b*) If the strong acid be added in great excess to the alkaloid a pale red tint is produced, which gradually deepens in colour.

2. *Sulphuric acid* produces no immediate change, but the mixture, after some time turns first a purple red, and then an olive green.

3. *Nitric acid* fumes in the presence of the alkaloid. The colour of the mixture is first pale red, then deep red, ultimately changing to a mass of colourless crystalline needles.

4. *Corrosive sublimate* gives a white amorphous precipitate, soluble in acetic, and in the mineral acids.

5. With *nitrate of silver* there is produced at first a brown precipitate of the oxide, which afterwards changes to the black suboxide.

6. *Oxalic acid* gives a white crystalline precipitate of oxalate of conia.

7. *Tannic acid* gives a dirty white precipitate soluble in hydrochloric acid.

8. *Iodine dissolved in iodide of potassium* gives a reddish amorphous precipitate, dissolving after a time, but reprecipitated by the addition of more of the re-agent.

9. *Carbazotic acid* gives a yellow precipitate, first amorphous, then crystalline, soluble in acetic acid, and in excess of the alkaloid.

10. *Perchloride of gold* (but not chloride of platinum) gives a yellowish white precipitate, insoluble in acetic and hydrochloric acids.

Toxicological Analysis.

In conducting a toxicological investigation search carefully for any leaves, or portions of leaves, in the stomach and intestines. These must be carefully examined as to their botanical characters. Do not mistake the leaves of parsley for those of hemlock. Of course the conium may have been administered as a decoction, when it is not likely you will find any remains of the plant. If you find the leaves, rub them up in a mortar with distilled water and potash, and see if the peculiar mousy odour of conia is exhaled. Then distil, and examine the distillate. Always attempt to recover the poison by this process before you try more elaborate systems of analysis. The blood, the tissues, and the contents of the stomach should all be examined separately for conia. We are of opinion that death should not be ascribed to the action of the poison unless the alkaloid be obtained on analysis, as the mere test of smell is scarcely sufficiently definite and distinct when life and death are concerned. For strong and peculiar as the odour of conium is, it is possible to be misled.

The following process for the detection of conia is recommended :—

Digest, by the aid of slight heat, the organic liquid, or the solid tissues (in which the alkaloid has been found by Stas) cut up very fine, for some time in water acidulated with acetic acid, and then strain through muslin. Evaporate down the filtrate on a water bath to a thick syrup ; mix this with strong spirit, and add a few drops more of acetic acid ; filter, and evaporate the filtrate nearly to dryness on a water bath. Add to this about ʒij of water to dissolve the acetate of conia ; filter, and add excess of caustic potash, to liberate the alkaloid. See if the peculiar odour of the poison at this stage is noticeable, and then shake the filtrate up with ether, repeating the operation several times. Decant the ether, and allow it to evaporate spontaneously in a cool place in watch glasses, when, if conia be present, it will be left in the form of oily drops. Dissolve the alkaloid in a few drops of water. This solution should be tested by the several reactions already described. A slight heat serves more completely to develop the odour.

Wormley advises the following process in obtaining conia from blood :—

Acidulate the blood with acetic acid, and shake it up thoroughly with its own volume of a mixture of water and alcohol (equal parts). Heat the mixture moderately, so as to coagulate the albumen, and strain the liquid through fine muslin. Evaporate the solution on a water bath to about half its bulk ; mix with a little strong alcohol, and again strain or filter off any coagulated matters that may have formed. Evaporate the filtrate nearly to dryness, removing, if necessary, again and again, any solid matters by filtration. Add to the residue a little water and caustic potash, and note if the peculiar odour of the poison can be detected ; after which proceed to extract the alkaloid with ether. Proceed then as before.

Cases of Poisoning with Conium.

<table>
<tr><td colspan="3">1.
"Edinburgh Medical and Surgical Journal," July, 1845, p. 169 (Dr. J. H. Bennett). Male. Leaves eaten by mistake for parsley.</td></tr>
<tr><td><i>Symptoms.</i>—In 20 minutes loss of power occurred in legs, but no pain ; paralysis of arms and legs complete in 2 hours; could not swallow; partial loss of sensation ; no convulsions ; pupils fixed ; intellect clear. Death in 3¼ hours from paralysis of the muscles of respiration.</td><td><i>Result.</i>—Death in 3¼ hours.</td><td><i>Post-mortem.</i>— Serous effusion beneath arachnoid ; <i>brain</i> soft, but fairly healthy; <i>lungs</i> gorged ; <i>heart</i> flabby ; <i>stomach</i> congested, with extravasation of dark blood below the membranes ; <i>intestines</i> here and there congested ; <i>blood</i> fluid and dark. The green conium leaves in a state of pulp were found in the stomach.</td></tr>
<tr><td colspan="3">2.
Taylor's "Medical Jurisprudence," vol. i., p. 418. Child. Part of a teacupful of a decoction.</td></tr>
<tr><td><i>Symptoms.</i>—The child sipped it, and shortly afterwards became paralyzed and insensible, and died in a sitting posture after 1 hour.</td><td><i>Result.</i>—Death in 1 hour.</td><td><i>Post-mortem.</i>—No morbid appearances ; no leaves found in stomach as these had subsided in the teacup.</td></tr>
<tr><td colspan="3">3.
"Orfila Toxicologia," vol. ii., p. 537 (M. Haaf). Male : adult. Soup mixed with conium leaves.</td></tr>
<tr><td><i>Symptoms.</i>—Soon fell asleep, and was found insensible and breathing hard after 1½ hour. An emetic was given, and he died in 3 hours.</td><td><i>Result.</i>— Death in 3 hours.</td><td><i>Post-mortem.</i>—Blood very fluid ; brain congested.</td></tr>
</table>

4.

Stillé's "Materia Medica," vol. ii., p. 268. Male : adult. ʒx of the extract.

Symptoms.—Became insensible ; convulsions.	*Result.*—Death in 2 hours.	

5.

"Christison." Female : old. ℥ij of a strong infusion, with ℥ij of whisky.

Symptoms.—Coma ; convulsions ; death.	*Result.*—Death in 1 hour.	*Post-mortem.* — Blood fluid ; brain slightly congested.

6.

Pareira's "Materia Medica," vol. ii., p. 732. Male.

Symptoms.—General paralysis ; saliva ran from the mouth ; urine and fæces involuntarily expelled. Did not lose sensibility.	*Result.*—Recovery.	

7.

"Philosophical Transactions," vol. xliii., No. 473, p. 18 (Dr. Watson). Two soldiers. Broth with conium leaves mixed in it.

Symptoms—Giddiness ; coma ; convulsions ; death.	*Result.*—Death in 3 hours.	

8.

"Lancet," Sep. 20, 1851, p. 276. Male : æt. 5. From the blowing whistles made of conium twigs.

Symptoms.—Usual symptoms.	*Result.*—Death.	

See also the following Cases of Conium Poisoning:—

"Medical Times and Gazette," July 7, 1855, p. 51. (Death.)
"Medical Times," March 23, 1844, p. 456. (Death from conium used as salad.)
" Aug. 12, 1848, p. 244. (Trial for poisoning by conium.)

Œnanthe Crocata.

(Hemlock Water-Dropwort ; Five-finger root ; Dead Tongue.)

This plant is indigenous, and is usually found growing near water, and is generally from 4 to 5 feet high. It is one of the most actively poisonous of English plants, although from some obscure cause, specimens have been found that seem to be almost inert. All parts of the plant are poisonous, but especially the root. Even emanations from the plant are said to have proved injurious to health.

The *root* (which is somewhat like a bundle of parsnips, and has more than once been eaten for them by mistake) consists of a series (2 to 10) of oblong tubers with rootlets. Its taste is said not to be disagreeable.

The *stem* is round and smooth. The *fruit* oblong and black. The plant when not in flower is very like celery.

The whole herb abounds in a fœtid yellow juice, which stains the hand, and yields by inspissation a gum-resinous extract in which the active principle of the plant resides. A rabbit died in seventy-eight minutes after 24 grains (prepared from about 8 ozs. of the root) of this gum resin had been introduced between the skin and muscle.

Symptoms.

The symptoms usually set in rapidly, and often in as short a time as twenty minutes. Their termination may be equally rapid, possibly only a few minutes intervening between death and the commencement of the symptoms. Giddiness, staggering, violent tetanic convulsions, and even opisthotonos are recorded; the patient may at last pass into a state of perfect insensibility, the face becoming livid and bloated, with bloody foam issuing from the mouth. Stertorous breathing is an ordinary symptom. The pupils are generally dilated. There is often considerable irritation of the alimentary canal. The nervous symptoms are usually very severe if death be at all delayed. Death usually takes place in from half-an-hour to two hours.

Treatment.

Emetics, the stomach-pump, and castor oil, must constitute our chief remedies, in order to get the poison out of the system as speedily as possible.

Post-mortem Appearances.

The post-mortem appearances are usually great general congestion of the brain, engorgement of the lungs, and signs of considerable stomach irritation.

Phellandrium Aquaticum.

(Five-leaved Water Hemlock).

The root of this plant has been mistaken for parsnips, and has produced bad symptoms.

Cases of Poisoning with the Water Hemlock.

1. "Medical Times and Gazette," March 6, 1858, p. 241 (Dr. Grahame). Several cases of eating the roots.		
Symptoms.—Convulsions and opisthotonos occurred in all the cases.		
2. "Medical Times and Gazette," March 6, 1858, p. 241 (Dr. Grahame). Male. The root.		
Symptoms.—Constant eructations, griping, and debility; became insensible; dilated pupils; bloody foam issued from mouth; opisthotonos; tetanus; death 10 minutes after the surgeon saw him.	*Result.*—Death.	*Post-mortem.*—On making the post-mortem, the peculiar odour of the plant was very apparent; stomach very congested.
3. "Medical Times and Gazette," Sep. 25, 1869, p. 379 (Dr. Kane). Female: æt. 4. Either Œnanthe crocata or the fool's parsley (?).		
Symptoms.—Convulsive twitchings of the muscles of the face; rigid spasms of body and limbs.	*Result.*—Recovery.	

4.

"Medical Times and Gazette," Sep. 6, 1862, p. 263 (M. Baume). Several cases. Root.

Symptoms.—One had convulsions and died in a few minutes.	*Result.*—Death in a few minutes.	*Post-mortem.*—Brain very congested.
Seven others were ill from taking it.	*Result.*—Recovery.	

5.

"Medical Gazette," vol. xxxiv., p. 288 (Mr. Bossey). A number of convicts ate the leaves and roots.

Symptoms.—(1) Strong convulsions came on in 20 minutes; bloated, livid face; bloody foam from mouth and nostrils; insensibility and stertorous breathing.	*Result.*—Death in 5 minutes after the symptoms commenced.	*Post-mortem.* — Cerebral vessels not congested; pharynx white and contained mucus; lining membrane of windpipe injected with dark blood; lungs gorged; blood in the heart black and fluid; mucous membrane of stomach much corrugated; follicles enlarged.
Symptoms. — (2) Symptoms similar; stomach pump used.	*Result.*—Death in 15 minutes after commencement of symptoms.	*Post-mortem.*—Similar to last case, with congestion of cerebral vessels.
Symptoms.—(3) Symptoms similar.	*Result.*—Death in 1 hour.	*Post-mortem.*—Similar to last case.
Symptoms.—(4) Symptoms similar.	*Result.*—Death in 1 hour.	*Post-mortem.*—Similar to last case.
Symptoms. — (5) Symptoms similar. Irritation of alimentary canal.	*Result.*—Death in 9 days.	*Post-mortem.*—Similar to last case. Mucous membrane of stomach and bowels softened and thickened.
Symptoms. — (6) Symptoms similar. Irritation of alimentary canal. Several recovered.	*Result.*—Death in 11 days.	*Post-mortem.*—Similar to last case.

6.

Taylor's "Medical Jurisprudence," vol. i., p. 422. Two labourers ate some of the roots.

Symptoms.—Both were found speechless and insensible some time after, faces livid, tongues protruding, frothy and bloody mucus about their mouths; pupils dilated, stertorous breathing; convulsions.	*Result.*—Death in 1½ hours from the time they were discovered.	*Post-mortem.*—Stomachs softened and congested; lungs engorged with dark liquid blood.

7.

"Gaz. Med.," Jan. 3, 1846, p. 18. Woman tried to poison her husband by mixing slices of the root with his soup.

8.

Beck's "Medical Jurisprudence," p. 917. Two men ate the roots.

Symptoms.—Both felt a great heat of stomach, and after a time in both the mind became affected; one had convulsions.	*Result.*—One died in 2 hours and the other in 3.	

See also the following Cases of Poisoning by the Water Hemlock.

"British Medical Journal," Feb. 23, 1861, p. 213.
" " " March 16, 1861, p. 293.

There are numerous other plants and vegetable substances which at times have proved poisonous, amongst which are the following:—

Chelidonium Majus (Celandine) and C. Glaucium.
Gratiola officinalis (Hedge Hyssop).
Mercurialis Perennis (Herb Mercury).
Clematis Vitalba (Virgin's Bower).
Pedicularis Palustris.

Tolu plant of New Zealand ("British Medical Journal," Aug. 24, 1867, p. 169).

Cape Herbs ("British Medical Journal," Aug. 8, 1874, p. 168).

Locust Nuts ("Medical Times and Gazette," Feb. 21, March 7 and 14, June 6, 1857).

Wattle gum ("Medical Times and Gazette," March 25, 1871, p. 353).

Coffee (severe symptoms from 250 grams: see "Medical Times and Gazette," Nov. 22, 1873, p. 585).

Œnanthe Sofranée ("Medical Times and Gazette," Aug. 23, 1856, p. 205).

Green tea ("British Medical Journal," March 28, 1874, p. 416).

Coriaria Ruscifolia (Toot poison) ("Medical Times and Gazette," May 16, 1863, p. 512).

Misletoe Berries ("British Medical Journal," Jan. 12, 1867, p. 42).

Vanilla ("British Medical Journal," Dec. 7, 1872, p. 636; and Vrtljhrischrft, f. Gerich. Med. N. F. xvi., p. 255).

Dahlia root ("Medical Times," April 7, 1849, p. 456).

Common liquorice ("Medical Times," Dec. 2, 1848, p. 140).

Upas Tree ("British Medical Journal," July 25, 1863, p. 81.)

Laurel Roses ("Medical Times," March 23, 1844, p. 456).

Poison of Pahonin (Dec. 14, 1872, p. 855).

Strophanus Hispidus (*Inœa*) ("Lancet," Dec. 7, 1872, p. 827).

The following Cases of Poisoning by various Plants are also recorded, and are quoted without Classification:—

(I). MOUNTAIN ASH BERRIES. (Rowan Tree). (Pomaceæ.)

1.

"Lancet," Sep. 18, 1858, pp. 317 and 343 (Mr. Rickard). Æt. 5. Somewhat doubtful as to the true cause, but believed to be due to the berries.

	Result.—Death.	

(II.) MISLETOE BERRIES.

2.

"British Medical Journal," Feb. 21, 1874, p. 224 (Dr. Dixon). Male: æt. 14. Misletoe berries.

Symptoms.—In 40 minutes he became insensible, and the pupils slightly dilated. He afterwards rallied, but was troubled with spectral illusions and violent delirium for some time; the berries were vomited after an emetic had been given. After a sound sleep he woke up well.	*Result.*—Recovery.	

(III.) KIDNEY BEANS (Leguminosæ).

3.

"British Medical Journal," April 30, 1864, p. 471 (Mr. Dale). Æt. 5. Several kidney beans were swallowed that had become somewhat mildewed.

Symptoms.—Appeared at one time to be dying; pulse almost imperceptible; pupils dilated and the eyes insensible to light; coma.	*Result.*—Recovery.	

(IV.) SCARELT RUNNER BEANS.

4.

"British Medical Journal," April 9, 1870, p. 359 (Mr. George Weller). Male: æt. 11. Ate 6 beans.

Symptoms.—Violent symptoms of irritant poisoning, with collapse.	*Result.*—Recovery.	

(V.) WILD PARSNIP (Sium Latifolium). (Apiaceæ.)

5.

"British Medical Journal," Dec. 13, 1873, p. 695 (Dr. White). Male: æt. 49. About 1 oz. of the fresh root.

Symptoms—Vomiting, purging, dizziness; loss of voluntary motion and mental power.	*Result.*—Recovery.	

See also "British Medical Journal," Dec. 4, 1869, p. 614. Strychnia symptoms.

(VI.) CANNABIS INDICA.

6.

"Lancet," Sep. 30, 1871, p. 493. Female: æt. 30. 7·5 minims of the tincture.

Symptoms.—Drowsiness; vision dimmed; sickness; thirst: in 4 hours pupils became very dilated; eyes suffused; tongue dry; the patient appeared very drowsy; by the next morning she was well. At the time the drug was taken she was 3 months pregnant, but she was confined at the full time.	*Result.*—Recovery.	

For other cases see "Medical Times and Gazette," Nov. 28, 1863, p. 572. (Bad symptoms from 4 grains.)
"Medical Times and Gazette," Feb. 7, 1852, p. 37.

(VII.) TANSY.

7.

"Medical Times and Gazette," April 13, 1861 (Dr. Pendleton). Female: æt. 21. A strong decoction taken to procure abortion.

Symptoms.—Became incoherent; pupils contracted; afterwards coma and paralysis of the voluntary muscles set in; no spasms or convulsions; no action of the uterus; death in 26 hours.	*Result.*—Death.	

(VIII.) OIL OF TANSY.

8.

"Canada Medical Journal," Nov. 1869. Female. A teaspoonful taken to induce miscarriage.

Symptoms.—Coma; pupils dilated; did not miscarry.	*Result.*—Recovery.	

(IX.) PINK ROOT (Carolina Pink).

9.

"British Medical Journal," April 9, 1870, p. 379 (Dr. Fred Mackenzie). Male: æt. 2. Three doses of an infusion of pink root taken for worms = ʒj of pink root.

Symptoms.—Coma.	*Result.*—Death.	*Post-mortem.*—Stomach very inflamed

CHAPTER XIII.

Cyanogen and its Compounds.

Cyanogen—Preparation—Action on animal and vegetable life—*Chloride of Cyanogen*—*Hydrocyanic acid*—Varieties—Properties—Strength of the different acids in use—Symptoms—Action on animals—Questions of medico-legal interest—(1) Dose—(2) Action of vapour—(3) As to its cumulative action—(4) Time when symptoms commence—(5) Possibility of voluntary acts before death—(6) The shriek—(7) Convulsions—(8) Involuntary expulsion of urine and fæces—(9) Time of death—Treatment—Post-mortem Appearances—Tests—Toxicological analysis—*Essential oil of bitter almonds*—Properties and uses—Symptoms in man and animals—Bitter almond water—*Prunus lauro cerasus*—Action of the oil and water—*Peach*—*Mountain ash*—*Cluster cherry*—*Cyanide of potassium*—*Silver solution*—*Ferrocyanide of potassium*—*Sulphocyanides*—*Cyanic acid.*

CYANOGEN (Κυανος γεννaω).

(C N or Cy. Sp. gr. 1·806.)

Cyanogen is not found in nature in a free state. In small quantities it is produced during the distillation of pit coal. It may be prepared by heating the cyanides of silver or of mercury in a glass tube when the gas is set free from its combination with the metal.

$$\mathrm{Hg\ Cy_2 = Hg + Cy_2.}$$

Cyanogen is a heavy, transparent, colourless, pungent smelling gas. It is combustible, and burns with a rose-coloured flame. It is soluble in water and in spirit. It condenses to a liquid at a temperature of —30 C. and freezes at —34·4 C.

Its physiological action has been examined by several investigators, and amongst others, Coullon, Hünefeld and Buchner. *Buchner* found that a small bird died almost instantaneously when held over a jar of the gas—and he describes how one of his own fingers became benumbed, and a peculiar feeling of stiffness in the thumb and elbow produced, merely from being exposed for an instant to its action. Hünefeld, in experimenting with it upon rabbits, describes, as the general effects, convulsions, dilated pupils, coma, and death in five or six minutes, similar symptoms being produced by it, according to Coullon, upon other animals. The coma was, in nearly all cases, well marked.

The action of cyanogen on plants is very intense. Turner and Christison state that 1 part in 1700 of air will destroy mignonette in twenty-four hours. The authors, however, have observed that geraniums placed in an atmosphere consisting of one part of the gas in 10,000 of air, soon wither and die, whilst one part in 200 of air will induce coma in small birds within twenty-four hours.

Chloride of cyanogen ($\mathrm{Cy_3\ Cl_3}$) is highly poisonous. It is corrosive when applied to the skin. One grain killed a rabbit in twenty-five minutes (Serullas.)

HYDROCYANIC ACID.

(*Prussic Acid.*) HCy or HCN.

Prussic acid may be prepared by passing electric sparks through a mixture of acetylene ($C_2 H_2$) and nitrogen.

$$C_2 H_2 + N_2 = 2 \text{ HCN}.$$

Varieties.

Pure anhydrous hydrocyanic acid, although an intense poison, decomposes so rapidly that it is not likely to be used for poisoning purposes. It is, therefore, of but little interest toxicologically. It may be prepared by passing sulphuretted hydrogen over mercuric cyanide.

$$\text{Hg} \left\{ \begin{matrix} \text{CN} \\ \text{CN} \end{matrix} \right. + H_2 S = (\text{HCN})_2 + \text{Hg S}.$$

It is a colourless and exceedingly volatile liquid, boiling at 26·5 C., the vapour being inflammable. It freezes at —15·C., and has a sp. gr. of 0·697. It rapidly decomposes, so that it can scarcely be kept for an hour if exposed to the light, a brown flaky substance being formed in the liquid, consisting chiefly of paracyanogen.

Dilute hydrocyanic acid is prepared by dissolving 2¼ ounces of ferrocyanide of potassium in 10 ounces of dilute sulphuric acid (1 of acid to 4 of water.) This is heated slowly in a retort, a condenser being attached containing 8 ounces of water. The distillation is to be carried on until there is 17 ounces in the receiver. This is to be diluted (according to the B.P.) until 109 grains of the solution, precipitated with nitrate of silver, yields 10 grains of dry cyanide. The following formula represents the reaction.

$$2 \text{ } K_4 \text{ Fe } Cy_6 + 6 \text{ } H_2 SO_4 = \text{Fe } K_2 \text{ Fe } Cy_6 + 6 \text{ } KHSO_4 + 6 \text{ H Cy}.$$

The dilute acid is a colourless, and very volatile liquid. It has a peculiar and well-known bitter taste, and an almond odour. It reddens litmus paper slightly, but the effect is not permanent. Prepared as directed above, it has a sp. gr. of 0·997, and contains 2 per cent. of anhydrous acid. Although the weak acid does not decompose so rapidly as the strong acid, still in addition to loss of power owing to its volatility, it also undergoes in time considerable changes, the brown flakes of paracyanogen, to which allusion has already been made, being found to form in the solution.

If pure, the acid should give no precipitate, either with sulphuretted hydrogen, or with a Baryta salt.

Strength of different Acids.

The strength of the different acids in use varies. No other acid should be used in dispensing than the standard acid of the pharmacopœia. In this way accidents might often be prevented. The authors have found that samples of the acid used by dispensing chemists, vary greatly in strength. Of sixteen samples, collected in one neighbourhood, the anhydrous acid ranged from 0·6 to 3·2 per cent. The variations are due to its mode of manufacture, the length of time it has been kept, and the extent to which it has been exposed to the light.

Strengths of various Pharmacopœal and other acids.

	Anhydrous Prussic Acid in 100 parts.
America	2·0
Austria	2·5
Baden	
Batavia	
Bavaria	4·0
Hessia	18·0 to 20·0
London	2·0
Dublin	3·3
Edinburgh	3·3
Hamburgh	2·0
Saxony	1·9
Paris	10·5
Scheele's acid	5·0
Vauquelin's Acid	3·5

In every form, to every animal, and however administered, hydrocyanic acid is an intensely active poison. Swallowed, inhaled, injected, or even sometimes when merely applied to the sound skin, its action is energetic. Dr. Letheby has twice fallen down insensible by accidentally smelling a bottle full of the strong acid. To its presence, the poisonous qualities of the essence of cherry kernels, bitter almond water, and laurel water, are due. The kernels of fruits like the peach, plum, and cherry, the pips of the apple, the bitter almond, the mountain ash, the leaves of the cherry laurel, the juice of the root of the jatropha manihot a plant that yields tapioca (bitter cassava), contain it as their active poisonous ingredient ("Lancet," Jan. 4, 1868, p. 30). Good Kirschwasser will be found at times to contain as much as 0·2 of a grain of anhydrous acid in 3½ ounces, whilst inferior specimens often contain four times as much ("Lancet," March 18, 1865).

Symptoms.

The symptoms of poisoning by prussic acid are influenced by a variety of circumstances, some of which it will be necessary to discuss in detail—

(*a*) Given in medicinal doses (♏ij to ♏x of the B. P. acid) it allays pain and spasms, and is found useful in relieving painful affections of the stomach, nervous cough, palpitation, etc.

(*β*) In a dose above this, but still short of a poisonous dose (♏x to ♏xx of B. P. acid) other symptoms may be produced, such as nausea, a feeling of impending suffocation, giddiness, and at times salivation and ulceration of the mouth.

(*γ*) Small poisonous doses of the acid (*e.g.*, ʒss. of B. P. acid) often produce severe symptoms, but they are not, as a rule, immediate in their appearance. The patient will complain of a hot *bitter* taste, whilst an increasing weakness and giddiness will probably be the first well-marked symptom, accompanied by severe pains in the head, and a gradually progressing confusion of intellect. At length insensibility supervenes with a more or less complete loss of muscular power. The eyes become bright and prominent, and the face pale or bloated. Very frequently salivation, with ulceration of the mouth, sets in. The jaw is often rigidly contracted, tetanus being a commoner symptom after medium-sized than after very large doses. The pulse is quick, and the breathing stertorous, with often a mucous rattle. Vomiting is not common, but if it occurs it is to be regarded as a hopeful symptom. Preceding death, which, under these cirumstances, will probably be due to *suffocation*, we may have strong tetanic convulsions, at times opisthotonos, and involuntary evacuations of the urine, or fæces, or both. In all probability the medical man will discover the odour of the poison in the breath.

(δ) Of the symptoms of a large dose we cannot be so well informed because of its "lightning action."

Whilst the poison is yet in the mouth it may begin to act, but the action is not, as a rule, so instantaneous in the human subject, as it has been observed to be in the lower animals. It is, however, not usual for more than two minutes to elapse before the appearance of symptoms. The patient probably falls down insensible. The face and skin will generally be found bathed in a cold, clammy perspiration, the hands violently clenched, whilst the eyes will appear fixed, prominent, and glistening, and the pupils widely dilated. The breathing will be stertorous, convulsive, and gasping, the odour of the poison being clearly noticeable in the breath. The pulse will be almost imperceptible. Involuntary evacuations of urine and fæces are not uncommon. As a rule, death takes place with a forcible expiration, which may or may not be accompanied by a shriek. Convulsions do not ordinarily occur in these rapidly fatal cases, but if death be at all delayed, convulsions, with spasmodic closure of the jaw, are almost certain symptoms. And under the circumstances above described, we may regard death as due to *shock*.

Action on Animals.

The symptoms in animals were accurately observed by Emmert in 1805, by Coullon in 1819, by Krimez in 1827, and by others, as Dr. Letheby, Dr. Glover, &c.

The symptoms produced by a dose just short of that capable of destroying life commence usually in from one to two minutes. Giddiness, staggering, and insensibility, with absolute loss of motive power, will be the first noticeable symptoms, and these will be succeeded by a violently gasping, panting respiration, and by tetanic convulsions, salivation, and protrusion of the tongue and eyes. Very often during the convulsions the sensibility returns, the return of consciousness being sudden and unexpected. Not unlikely, moreover, the animal will fall into a deep sleep, after which it will wake up better. These symptoms may last for a period varying from twelve to twenty-four hours.

But the dose administered may be enough to cause death, but not enough to cause it instantaneously. Under these circumstances the fatal moment may be delayed for some few minutes, although seldom beyond a quarter of an hour. At the same time it is right to state that some observers have recorded a much longer intermediate period than this. A peculiar death-like shriek will frequently be remarked immediately preceding the fatal moment. Death will probably be due to suffocation from the spasmodic action of the respiratory muscles, and be accompanied by coma and by well marked tetanic convulsions. Hence it must not be forgotten that poisoning with prussic acid may clearly simulate an ordinary epileptic fit.

Lastly, when large doses are administered, the effects on animals are almost absolutely instantaneous.

(See a valuable monograph by Preyer, "Die Blausäure," and also some remarks on hydrocyanic acid poisoning by Dr. Amory (Boston), "The Practitioner," viii., p. 197.)

So many questions of grave medico-legal interest occur here, that we shall proceed to discuss them *seriatim*.

1. *The Question of Dose.*

And here it may be well first of all to note the relationship between minims and drops. The size of a drop depends to a great extent on the mouth of the bottle, the rapidity with which the drops fall, and the nature of the liquid. The following results are averages of a large number of experiments, all of which were made by dropping the different liquids from the same bottle, and as nearly as possible at the same rate:—

10 drops	of Water measure	from	20 to 22	minims.
10 ,,	of Hydrocyanic Acid	,,	19 to 21	,,
10 ,,	of Acetic Acid (strong)	,,	8 to 9	,,
10 ,,	of Chloroform .	,,	5 to 6	,,
10 ,,	of Ether .	,,	9 to 10	,,
10 ,,	of Benzol .	,,	9 to 10	,,
10 ,,	of Spirit .	,,	16 to 18	,,
10 ,,	of Nitric Acid .	,,	8 to 9	,,
10 ,,	of Tincture of Opium	,,	5 to 6	,,
10 ,,	of Tincture of Aconite	,,	6 to 8	,,
10 ,,	of Tincture of Hyoscyamus	,,		
10 ,,	of Tincture of Digitalis	,,		

What is the smallest dose of prussic acid that will prove fatal—

(*a*) *In animals.*

Magendie's experiments show that :—

One drop of anhydrous acid injected into the jugular vein of a dog proves fatal instantaneously.

One drop of anhydrous acid given by mouth to a dog killed it in a few seconds.

Christison's experiments show :—

1 drop	of anhydrous acid	given to a rabbit	began to act in	63	secs.,	and proved fatal in	83 secs.
3 drops	,,	cat	,,	10	,,	,,	30 ,,
3 ,,	,,	cat	,,	[illegible]	,,	,,	40 ,,
4 ,,	,,	rabbit	,,	20	,,	,,	30 ,,
3 ,,	,,	placed in the eye of a cat	,,	20	,,	,,	40 ,,
3 ,,	,,	placed in a flesh wound on a cat	,,	45	,,	,,	105 ,,
℥iss	of medicinal acid	given to a rabbit	,,	instantly		,,	10 ,,

Christison notes that in the cases where death was slow, there were fits of tetanus. Emprosthotonos was the principal tetanic symptom in cats, and opisthotonos in rabbits.

These experiments prove that 1 grain of anhydrous acid, and possibly less, will prove fatal to animals.

(β.) *In man.*

It is commonly stated that in the well-known case of the Parisian epileptics, death was produced by two-thirds of a grain of anhydrous acid. There is, however, great reason to doubt the accuracy of this statement, Guibourt believing that the quantity actually swallowed by each, was about 5·5 troy grains. Omitting these cases, therefore, the smallest fatal dose of which we have record (case recorded by Dr. Letheby), is 0·9 of a grain of anhydrous acid (= 20 m. of Scheele's acid), which destroyed the life of an adult in twenty minutes. The poison was taken on an empty stomach. Whilst, however, we are justified in saying that 1 grain of anhydrous prussic acid may prove fatal, we are clearly not justified in assuming that it necessarily must, for recovery is recorded after such doses as a mouthful of pharmacopœa acid (Dr. Guy), 2 drams of Vauquelin's acid; and after 0·9 grain (Mr. T. Taylor), 1·33 grains (Mr. Bishop), 1·5 grains (Christison), and 2·4 grains (Mr. Burman) of anhydrous acid. The possibility, therefore, of treatment being successful in cases of poisoning by prussic acid, as in other forms of poisoning, cannot be too emphatically insisted upon. Nothing can justify a medical man doing nothing so long as there is life, however desperate the case may seem.

All experimenters agree with Mr. Nunneley, that the energy and activity of the poison is not destroyed or materially lessened by mixing it with water, and that a given dose acts similarly, whether administered in its anhydrous state, or in any degree of dilution.

Further, the potent action of the acid is very considerably increased by disease, by blood-letting, by fatigue, by hunger, or by any other circumstance which tends to debilitate the vital powers of the patient. Under these circumstances, a dose of the acid will prove fatal, which in a vigorous person or animal might have been swallowed with impunity.

2. *The poisonous action of the vapour of the acid.*

A bird placed in a glass, the air of which is saturated with the vapour, drops down dead instantly. If 1 drop of anhydrous acid be left for a few minutes in a clean dry quart bottle, the air in the bottle will be so poisoned, that if a bird be placed in it, it dies in a few minutes. As a rule the vapour does not act on or through the sound skin, still there are exceptions to this. For example, M. Robiquet found that the exposure of his finger to the action of the vapour benumbed it, the want of sensibility being persistent for some days. Another case is recorded where a chemist lost his life from spilling the acid on his naked arm, but of course in such a case the inhalation of the vapour might have been the true and primary cause of the fatal result. ("Coullon Recherches," p. 200). For as we have already observed, the inhalation of the vapour has been attended with serious results (M. Danuron: "Journ. de Chimie Medicale," vii. 426). Dr. Ittner found that he suffered considerable oppression and giddiness from breathing the atmosphere of his laboratory, in which the vapour of the poison was diffused (Beck). Dr. Heller records a case of severe tetanic symptoms being induced by merely smelling a bottle containing Scheele's acid. Dr. Letheby, as we have already mentioned, has been twice rendered insensible by smelling a bottle of the acid which had been carelessly left unlabled.

3. *Is prussic acid a cumulative poison? i.e.*, will continued small doses given medicinally, silently accumulate in the system, and at last break out, like mercury and digitalis, with fatal violence? This is a question that has been more than once raised, and we may say that all evidence is opposed to the view that it can act in this manner. Only one case can be quoted in proof of the possibility of such a thing occuring (that of Dr. Baumgärtner), but the details of the case present so many doubtful points, that we may fairly question the accuracy of the records. So volatile a poison is not likely, we should suppose, to be cumulative, nor can we understand any drug being of this nature, which is capable of acting so easily in disturbing the balance between life and death.

4. *As regards the time when the symptoms commence*—

(*a*) *In animals.* When a very large dose is administered, the commencement of the symptoms is, as nearly as possible, instantaneous. The animal drops down senseless whilst licking the milk in which the acid has been placed. Dr. A. T. Thompson records having seen a dog die in two seconds after taking a dose of the concentrated acid. Christison's experiments prove that with very large doses death is often instantaneous, whilst with moderately large ones, a period of from five to sixty-three seconds may be regarded as the length of the intermediate stage between the administration of the poison and the beginning of the symptoms (page 456). Experiments on animals prove then, that the symptoms may set in without any apparent interval, or else be delayed for one, or at the most, two minutes.

It is right we should add that Mr. Blake holds that even after the injection of as large a dose as 39 minims of the concentrated acid into the femoral vein, the poison never begins to act in less than ten seconds. Mr. Blake is almost alone, however, in denying the instantaneous action of the acid upon animals.

(β) *In the human subject.* The symptoms are not so rapid in their appearance in man as they are in animals. In some cases they have been known to commence in the course of a few seconds. Even in Hünefeld's case, where 40 grains of anhydrous acid had been taken, a few seconds elapsed before the advent of the symptoms. It is, however, a rare thing for insensibility (which is *not* death, but is often mistaken for it) to be delayed beyond the second minute, but it is not uncommon for it to be delayed for a minute or a minute and a half.

And this question suggests our next consideration, which is one of great importance, viz. :—

5. *How far is it possible for voluntary acts, such as walking and speaking, to be performed in this interval?*

Dr. Guy records with singular precision and care, a case where a young man took a mouthful of acid, then got out of bed, walked to a chest of drawers at the foot of the bed, put the stopper in the bottle, and returned to the side of the bed again, and then, and not till then, fell down senseless. In another case a girl took, probably ʒivss. of the acid, and afterwards put the cork in the bottle, wrapped it up, lay down in bed, and adjusted the bed clothes. In a third case, a man is reported to have walked about fifty steps, and gone down a flight of seventeen stairs. Without multiplying cases of this kind, and they are not a few, another may be mentioned, for which we are indebted to Dr. Letheby, where two lovers deliberately took prussic acid, and after taking it, performed several little voluntary acts, finally arranging their arms round each other's necks, and so expired together. It is perfectly clear, therefore, that to a certain extent, voluntary actions may be performed after a large dose of the poison—but we should say, that if these voluntary acts could not be performed in a period not exceeding two minutes at the outside, they would be open to some doubt.

We need scarcely, however, remark that there are numerous cases where no time whatsoever occurred for voluntary acts to be performed.

As regards the possibility of *speaking* after taking the poison, we have again undoubted evidence. In Mr. Bishop's case, the patient gave an account of his feelings during the two minutes' interval. In a second case where an apothecary's apprentice took ℥j of the acid, from which he died in five minutes, he cried out "hartshorn, hartshorn," and when his companions reached him, he muttered "prussic acid." And a third case may be quoted (Dr. Sewell, Montreal) where a man, after taking ℥vii., of acid (3 per cent. of anhydrous acid) walked to the door, unlocked it and cried out, "Come to me quick, I am dying."

It follows, and it is important to note the fact, that very probably the vessel out of which the poison was taken in a case of suicide, will be found near the person, or at any rate at no great distance off, the absence of the glass or bottle being always suggestive of homicide. Of course if the bottle be left uncorked for any time, the odour of the poison from the bottle will soon disappear.

6. *As regards the shriek.*

(*a*) The shriek, which is a peculiarly hollow, painful sound, is often noticed in animals dying of the poison. In Mr. Nunneley's experiments, it occurred in about one half the cases.

(*β*) *What are the circumstances under which the shriek occurs?*—Dr. Letheby's experiments prove that when animals are in a state of exhaustion or fatigue, occasioned either by physical work or by want of food, the shriek is often absent.

(*γ*) *To what is the shriek to be attributed?*—Dr. Letheby believes it to be the immediate precursor of death, a true death scream, the last act of vitality; in other words, the last expiratory act of the animal. This is doubted by Dr. Glover, who states he has heard animals shriek and after that run about ("Lancet," May 24, 1845).

Now it has been frequently asserted by medical jurists that the shriek is never heard in the human subject. A case recorded by Dr. Letheby (that of Belaney, who was charged with poisoning his wife) disproves this assertion. No doubt the shriek is not nearly so common in the human subject as it is in animals, but there can be no possible reason to see why, as some assert, it should never occur.

Important questions have arisen, and may again arise respecting this shriek. Dr. Letheby, as we have said, contends that it is the last act of life. Belaney's statement, therefore, that after the shriek his wife was heard to make, she said to him, "I have taken some of that strong drink," Dr. Letheby considers could not have been true.

(7.) *As to the presence or absence of convulsions.*

(*a*) *In animals* they frequently, but not always, occur. Dr. Letheby remarks that when animals are hungry and fatigued, convulsions are not usual, whilst no convulsive action is ordinarily noticed, if the dose administered be sufficiently large to cause instantaneous death.

(*β*) *In man* they are also frequent, but by no means constant symptoms. Where death is very rapid from the exhibition of a very large dose of the acid, or when the patient is a person of a debilitated constitution, the convulsions may be exceedingly slight, or altogether wanting. Certainly the calm placid appearance observed in so many cases of death after prussic acid, and the symptoms of which there is no record, points to the absence rather than to the presence of convulsions during life.

A question has been raised in a court of law whether in a slow case of poisoning by prussic acid, the convulsions produced would not necessarily be so violent as to disturb all the bed clothes covering the patient. Our answer undoubtedly must be that convulsions, although commonly, are certainly not necessarily the consequences of an overdose of the poison, and that if they do occur they may be of a very slight character.

(8.) *As to the involuntary expulsion of the urine and fæces.*

In one-tenth of Mr. Nunneley's cases, the fæces alone were expelled—in one-tenth both fæces and urine—in one-fifth the urine only—and in two-fifths neither the one nor the other.

In the human subject the occasional expulsion of one or of the other has been observed. In Dr. Guy's case, both urine and fæces were expelled.

(9.) *As regards the time of death.*

(*a*) *In animals* death is sometimes *instantaneous.* But insensibility and the power to move, must not be confounded with death, for the two are distinct. Mr. Nunneley states that he has seen animals live after a large dose, for hours or even days. Coullon saw a dog live for nineteen hours in great suffering, after a full dose of the acid. Such cases, at any rate, are very rare, and have not occurred in the experience of most investigators. Schubarth states his opinion that if an animal lives over thirty-two minutes, it gets well.

Thus far, therefore, is certain that animals may die almost in the course of a second, or that they may live for some considerable time.

(*β*) *In man,* death is certainly not so immediate as it seems to be in animals, but it may occur within five minutes, or it may be prolonged to forty. A period of from two to ten minutes may be regarded as an average time after a dose of from 80 to 100 drops of dilute acid. And, further, it may be taken as a general rule that the patient dies rapidly or recovers. If life be prolonged over forty minutes, we are justified in pronouncing a favourable prognosis.

Treatment.

This divides itself into general and chemical.

I. *General.* Most frequently we are first called to see the case when all is over, but if only a spark of life remains (lateat scintilla forsan), we should not hesitate in using remedies. Often too, if the patient be alive, the jaw is so firmly fixed that efforts seem hopeless, but even this should not hinder us from giving them by a tube placed through the nose, or even extracting a tooth, if necessary, for the purpose of their administration.

(α) *Cold affusion* (De Herbst). Dash cold water instantly upon the face, head, and back. Do not be prevented doing this because of convulsions. As soon as possible rub the skin until it is warm and dry, and repeat the dose. No doubt cold affusion is best, if applied before convulsions set in, but it should never be omitted.

(β) *Artificial respiration* (Dr. Pareira), may be useful, and may be employed at the same time as the cold douche.

(γ) *Bleeding from the jugular vein* has been strongly recommended by Magendie, Cormack, and Lonsdale. It is stated that the cardiac contractions are restored by the abstraction of a little blood. We consider bleeding should only be adopted as a last resource.

(δ) *Ammonia* is most useful. It should be given internally in small doses, and the carbonate of ammonia held to the mouth and nostrils. It was first suggested by Mr. Murray of London, and approved by Orfila, M. Dupuy, and Buchner. Take care however, that the ammonia is not too strong, as otherwise you may induce inflammation of the mouth and air passages. The strong liquor ammoniæ should never be applied to the nostrils under any circumstances.

(ε) *Chlorine* (Riauz, 1822), was experimented upon as to its antidotal properties by Buchner, Simeon, Cottereau, Vallette, and Orfila. All agree that it is very useful. Orfila regards it as the most powerful of all antidotes. It will suffice for a little chloride of lime, mixed with a little water, to be held near the mouth and nostrils.

II. *Chemical.* Chemical antidotes are rarely of any use, because of the rapid action of the poison. The best antidote is a mixture of proto- and per-sulphate of iron in combination with a little caustic alkali. By this means the harmless potassic ferrocyanide will be formed, and if by chance the mixture should become acid, then the ferric salt would form the harmless Prussian blue. If this antidote can be obtained in time, there can be no question as to its utility.

Sulphate of iron alone has been suggested, but it is useless.

To sum up all. If you are called to a case of hydrocyanic acid poisoning, immediately use the cold douche and apply smelling salts to the nostril, or better still, chloride of lime. Keep the body dry and warm by friction with hot towels. Tickle the back of the throat with a feather, and if you can open the jaw, use the stomach-pump, or else give mustard or salt, or, better still, sulphate of zinc. Lose no time in getting the iron salts and the solution of caustic soda or potash, or even carbonate of soda.

Post-Mortem Appearances.

In some cases, as in that of Sarah Hart (case of Tawell) no morbid appearances have been found.

If death be rapid, the countenance, as a rule, is pale and composed, whilst if death be slow, it will appear bloated. Putrefaction is said to be rapid. Dr. Taylor doubts whether this is so, but we know that rapid decay is not unfrequent in all forms of sudden death. The eyes are usually glassy, glistening, and prominent; but these are states, it is to be remembered, equally characteristic of death by cholera, carbonic acid, epilepsy, &c. The pupils will generally be found to be widely dilated. The body is, as a rule, rigid, and the jaw firmly closed. There will probably be found a quantity of frothy foam about the mouth.

The *stomach and intestines* are often quite natural, but sometimes they are more or less congested. They were found in a dog that lived only a few minutes, to be almost as inflamed as if it had taken arsenic. One case is reported of gangrene, but the details must be received with caution. In Nunneley's experiments on animals, the congested condition of the stomach was the most common, and he further noticed that if the stomach was empty at the time the poison was administered, it was often contracted after death, and of a peculiar brick-dust colour.

The brain generally shows great vascular turgescence with serous effusion into the ventricles. The odour of the poison may often be distinctly recognised. In animals this state of turgescence of the vessels is particularly noticeable, the brain tissue itself appearing almost natural. In the case of a horse poisoned by the acid, extravasation of blood was found on the surface of the brain. In *the heart and great vessels*, if death be rapid, the left side is generally empty and rigidly contracted; but if death be slow, both sides will be found full, either of black and fluid, or of coagulated blood. Schubarth, Blake, and Magendie, in their experiments on animals, remark that the irritability of the heart and voluntary muscles after death, is so entirely destroyed, that they will not even contract by galvanism. Coullon disagrees with this assertion, whilst Lonsdale and Christison consider that it is by no means a universal rule. *The lungs, liver, spleen, and kidneys*, are invariably gorged with blood. The bile has more than once been noticed of a deep blue tint. The venous system is invariably gorged with dark-coloured blood, and the arterial system empty. The blood is always found to have undergone some peculiar alteration. It may be black or oily (Ittner), or of a cochineal-red colour (Emmert)—whilst sometimes it is fluid, and at other times coagulated. It often, too, exhales the odour of the poison, and should, in all cases, be preserved for analysis, as the acid may frequently be distilled from it.

Lastly, it is to be noticed that similar post-mortem appearances will probably be discovered, however the poison be administered, that is, whether it be applied to wounds or to the conjunctiva or introduced into the vagina, or rectum.

Tests.

1. *Nitrate of silver* gives with hydrocyanic acid and with the soluble cyanides, a dense white *amorphous* precipitate of *cyanide of silver* (Ag Cy), which, after stirring thoroughly, subsides, the liquid above the precipitate then becoming perfectly clear.

(α) The precipitate is not dissolved by adding a little nitric acid to the solution in which it has been thrown down. But,
(β) The precipitate itself is soluble in *concentrated* nitric acid when heated.
(γ) It is only slightly soluble in ammonia. If the precipitate be abundant, its solubility in ammonia will not be perceptible.
(δ) It is freely soluble in excess of the alkaline cyanides, and in the alkaline hyposulphites.

Collect the precipitate of cyanide of silver on a filter paper, wash thoroughly, and dry:

(ε) It will not be found to be altered in colour by exposure to light to the same extent as the chloride of silver.
(ζ) Place some of the *well-dried* cyanide in a reduction tube sealed at one end, the other end being drawn out to a fine point. Heat the cyanide with a spirit lamp, when cyanogen gas will be given off, which will be found to burn with a very characteristic rose-red flame. Metallic silver, when the gas is burnt off, will remain in the tube.
(η) Treat a small portion of the cyanide of silver in a beaker, with a few drops of sulphide of ammonium. Evaporate gently to dryness, when sulphocyanide of ammonium and sulphide of silver will be formed. Dissolve the sulphocyanide in water, and filter off the sulphide of silver. Concentrate the filtrate, and treat with a persalt of iron, when the liquid will turn a brilliant red colour.
(θ) Treat a little of the cyanide of silver in a deep watch-glass with hydrochloric acid; when hydrocyanic acid will be given off as a vapour, and chloride of silver be formed. Cover the watch-glass over, first, with a flat glass, having upon it a drop of potash solution, and afterwards with a second glass having upon it a drop of yellow sulphide of ammonium. These are to be tested as described (pages 464, &c.).
(ι) Heat a portion of the cyanide very gently with iodine in a small clean tube, when crystals of iodide of cyanogen will sublime and form on the cool part of the tube. These may be preserved in sealed tubes, and can be tested at pleasure by a solution of potash, and by a mixture of a per- and a proto-salt of iron as described (page 464).

The silver test is applicable to the detection of the vapour. Expose to the action of the vapour a drop of nitrate of silver solution on a glass slip (fig. 2, page 61). If the vapour be present in any quantity, the silver solution will almost instantly assume the form of a white opaque film. If the vapour be only present in very small quantity, the opacity will, first of all, be apparent at the edges of the drop, but afterwards extend towards the centre. If this be examined by the microscope, crystals in the form of slender prisms will be visible. Care must be taken not to confound these with crystals of nitrate of silver, produced by the evaporation of the water of the silver solution. The white film must be further tested as to its solubility by adding a drop of nitric acid.

[It must be noted—

(1.) That nitrate of silver also gives *a white precipitate* with hydrochloric acid, and with the chlorides, phosphates, and carbonates. But—

(*a*) All the above silver precipitates are soluble in nitric acid, excepting the chloride and cyanide.

(*b*) The chloride blackens on exposure to light rapidly, whilst the cyanide changes very slowly.

(*c*) The cyanide heated in a glass tube gives off cyanogen gas, which burns as a rose-red flame at the mouth of the tube, which, of course, the chloride does not.

(2.) Nitrate of silver gives *a yellowish white* precipitate with iodides, bromides, and their hydrogen acids, which precipitates are insoluble in cold nitric acid.

(3.) The vapours of chlorine, bromine, iodine, and their hydrogen acids produce a white opaque film when allowed to act upon a drop of a nitrate of silver solution. These vapours, however, are easily known by their peculiar smell, whilst the deposits produced by them are amorphous and not crystalline.]

2. *Prussian-blue Test.*

To an aqueous solution of hydrocyanic acid, carefully add a weak solution of potash until the odour of the acid entirely disappears. The object of this is to convert the acid into an alkaline cyanide, and of course, therefore, if the acid previously exists in this combination, it will be unnecessary to add the potash.

$$HCy + KHO = KCy + H_2O.$$

Now add to this a few drops of a solution of a mixture of a per- and proto-salt of iron,* when a dirty green precipitate is thrown down. The proto-salt converts the cyanogen into ferrocyanogen, which ferrocyanogen ($Fe\ Cy$), combines with the iron of the per-salt. Now add carefully, and in slight excess, dilute sulphuric acid, in order to re-dissolve the excess of the oxides of iron, when Prussian blue (sesquiferrocyanide of iron, $Fe_7\ Cy_9$) subsides as a distinct blue precipitate, which is insoluble in, and unaffected by, dilute acids.

If a mere trace of prussic acid only be present, the addition of the re-agents may produce at first but little change, but if the solution be allowed to stand, flakes of Prussian blue will form after a time.

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* Common green vitriol (or sulphate of iron), after exposure to air, may be regarded as certain to be a mixture of a per- and proto-sulphate, and its solution may consequently be used for this test.

The vapour of the acid may also be examined by this test. A drop of potash solution is to be exposed on a glass slide (fig. 2, page 61) to the action of the vapour, and after being allowed to remain for some time, the glass slide is to be removed, placed on a piece of white paper, and the drop of potash touched first with the mixed iron salts, and afterwards with a drop of dilute sulphuric acid, when the characteristic blue colour will be developed.

3. *Sulphur Test* (Liebig, 1847).

Add to a solution of a cyanide, or to a solution of the acid, a few drops of yellow sulphide of ammonium.[*] Allow this to evaporate spontaneously to dryness, or heat it very gently until nearly dry on a water bath, when a whitish deposit will be obtained, consisting of sulphur and sulpho-cyanide of ammonium.

Touch the deposit thus obtained with a glass rod moistened with a solution of persulphate of iron, when a blood-red colour (sulpho-cyanide of iron) will be at once produced. If this be touched with a—

(*a*) *Corrosive sublimate solution*, the colour will be discharged, whilst with

(*β*) *Hydrochloric acid*, the colour will remain unaffected.

[Note that—

(*a*) With *meconic acid*, persalts of iron also strike a red colour, but the colour is not discharged by corrosive sublimate.

(*b*) With *alkaline acetates*, a red colour is also produced, but the colour is discharged by hydrochloric acid.]

The heat applied to evaporate the solution down *must be sufficient*, or else the persalt of iron will be precipitated by the undecomposed sulphide. If this occurs, the precipitate can be readily dissolved by a drop of hydrochloric acid, which will not interfere with the reaction. But, on the other hand, the heat used *must not be too great*, or else the sulphocyanide will be decomposed, and the test rendered worthless.

The sulphur test may be adopted in the detection of the vapour. For this purpose, use a glass slide (fig. 2, p. 61), with a drop of yellow sulphide of ammonium upon it, so placed as to be freely exposed to the action of the vapour. After five or ten minutes remove the glass slide, and allow the liquid to evaporate slowly to dryness, when sulphocyanide of ammonium will be left. A blood-red colour will be produced when a drop of persulphate of iron is added.

In the case of *cyanides*, act upon them with a little of the yellow sulphide of ammonium (= m Cy S_2), then evaporate to dryness, and test the residue with a persalt of iron.

4. *Schönbein's Test.*

Saturate a sheet of white blotting-paper with an alcoholic solution of guiacum (15 grs. to ℥j), and dry gently. Dip a slip of the paper into a solution of sulphate of copper (10 grs. to ℥j), and hold it over a vessel where the vapour of hydrocyanic acid is being given off, when the paper will turn a deep blue colour.

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[*] That is strong ammonia supersaturated with sulphuretted hydrogen.

This test is very delicate, but it must be remembered that ozone acts similarly with this test to prussic acid. It is better therefore not to rely upon it.

5. The *Copper Test* (Lassaigne), is not recommended. It consists in precipitating the acid, as a cyanide of copper, by the addition of sulphate of copper.

In estimating hydrocyanic acid quantitatively, it must be precipitated as a cyanide of silver with nitrate of silver, in a solution acidulated with nitric acid. Collect, wash, dry, and weigh the precipitate.

A volumetric process on a similar principle is given at p. 14 of the octavo edition of the British Pharmacopeia.

Every 100 grs. of Ag Cy = 20·15 of anhydrous prussic acid.

Toxicological Analysis.

In conducting a toxicological inquiry, carefully, first of all, endeavour to detect the prussic acid odour in the various solids and liquids to be examined.

This may often be noticed directly the body is opened, or, at any rate, on opening the stomach.

Several facts respecting the odour of the poison are most important to bear in mind in conducting medico-legal cases.

1. The odour of prussic acid may be confounded with that of nitrobenzol, which, however, it must be remembered, is itself a poison.

2. The odour of the acid may often be detected in the stomach when it cannot be detected in other parts.

3. The odour, according to Dr. Letheby, may be detected for at least eighteen hours after death, whilst it has also been observed after twenty-two and thirty hours, and in one case after four days.

4. It is not true, as Orfila asserted, that the odour of the acid is perceptible when the chemical reactions with the several tests fail.

5. If the odour can be detected in the blood and in the limbs, the difficulty is met which is often raised, that a prussic acid odour may be present in the stomach, intestines, and brain, although no hydrocyanic acid has been taken.

6. Although death has been caused by prussic acid, no odour of the poison may be perceived.

- (α) *It may have disappeared* either (1) *by exhalation;* that is, dissipated by the lungs, owing to the time that has elapsed between taking the poison and death, being considerable; or (2) *by evaporation,* from the body having been exposed to the open air or rain; or
- (β) *The odour may be concealed,* being masked by other scents, such as tobacco, onions, peppermint, &c.
- (γ) Or, *non-volatile combinations may be formed,* as, *e.g.*, if sulphuretted hydrogen be set free during decomposition, sulpho-cyanides may be produced.

The peculiar *bitter taste* of the acid, which is specially to be detected at the back of the tongue, is very characteristic of its presence.

Having placed the contents of the stomach and other solid matters in a clean wide-mouthed bottle, test, first of all, their acidity or alkalinity. If alkaline, add dilute sulphuric acid, until the mixture has acquired a distinctly acid reaction; further note the quantity of acid necessary to effect this, which will serve as an indication of the amount of alkali present.

Stand the bottle in a basin containing a little warm water (fig. 2, page 61), and expose on clean glass plates a drop of the following reagents successively, for a few minutes, to the action of the vapour that will by this means be evolved.

(*a*) *Nitrate of silver* (*See* page 463).
(*β*) *Solution of potash* (*See* page 464).
(*γ*) *Sulphide of ammonium* (*See* page 465).

Test these in the manner already described. If no action be perceived on removing the glass slide with the nitrate of silver, it will be very little use trying the other two reagents.

Having finished these experiments, empty the contents of the bottle into a retort connected with a condenser, and apply heat by means of a salt-water bath. About one-half of the liquid in the retort is to be carefully distilled into a little water contained in a well-cooled receiver, the distillate obtained being examined by the various tests for an aqueous solution of the acid (page 463).

The analysis thus far suggests the further consideration of some important questions of detail :—

1. Carefully examine the acidity or alkalinity of the organic liquid (whether it be the contents of the stomach, articles of food, &c.). *If they do not show a distinctly alkaline reaction* to turmeric paper, they should be distilled as they are, and without any acid being added. *If they do show a distinctly alkaline reaction* (as they undoubtedly will if cyanide of potassium be the cause of death), then they must be acidulated before distillation, so that the acid may be set free.

2. If *the original liquid be found acid*, and on distillation you obtain evidence of prussic acid, any prussic acid found in the distillate must have existed in the original liquid as free prussic acid.

3. If *the original liquid be distinctly alkaline*, and upon adding an acid (such as sulphuric acid) and distilling, prussic acid be obtained in the distillate, the prussic acid must have existed in the original liquid as an alkaline cyanide, whatever may have been the form in which it was administered; *i.e.*, it may be in combination with ammonia generated during putrefaction, although in the first instance it was taken as free acid.

4. Never be in a hurry to acidulate the organic liquid. It is far better to distil at first without adding any acid at all, even if the liquid be neutral, inasmuch as it may be urged if acid be added, that the prussic acid obtained in the distillate was the result of the decomposition of sulpho-cyanide of potassium, which is a normal constituent of the saliva. At the same time we hold that this difficulty is fanciful. The quantity of sulpho-cyanide that can possibly get into the stomach from the saliva, must be so small, that it is difficult to conceive it to be a source of error; whilst the suggestion that the hydrocyanic acid obtained may arise from the presence of ferro-cyanides accidentally introduced (a most unlikely

circumstance), scarcely needs further consideration on account of the ease with which the existence or non-existence of this body in the original liquid can be proved. Of course, if no acid be added, neither the sulpho- or the ferro-cyanides could possibly furnish even a trace of the acid by distillation.

5. If you get no whitening of the silver solution by the vapour test, it is of no use, as we have said, trying the other vapour tests; but because the vapour tests are unsatisfactory, or even show no results, you should never neglect to distil.

6. If the silver solution upon being added to the distillate be blackened by the presence of a little sulphuretted hydrogen, which may have been generated by decomposition and pass over during distillation, at once try the sulphide of ammonium test, which will not be similarly affected.

7. If prussic acid be found, it may be urged by the defence that it is possible for it to be produced either during distillation, or in the process of decay by the decomposition of animal matters. Orfila and Schubarth believed this, whilst others have doubted it. If it can (and we are disposed to admit the possibility), it can only be in the minutest possible quantity, whilst the heat required to produce it, must be very much greater than that of a salt water bath. For this reason a higher temperature than that of a salt water bath should never be employed in the distillation.

Of course, this fact has been urged as an argument against the process of distillation altogether for recovering the prussic acid in toxicological investigations. The objection, however, is not of much force, as we are not likely to use a temperature of 600° or 700° F.

The production of prussic acid said to result during the decay of cheese (Witling) need merely be mentioned here.

8. Prussic acid may during the decomposition of the body, be converted into sulpho-cyanide of ammonium (from the sulphide of ammonium formed during putrefaction). In a case, therefore, where a body has been dead for a very considerable time, it will be well to render the materials *distinctly* but *not excessively* alkaline, by the addition of a drop or two of a solution of caustic potash, and then to act on them with alcohol, which will dissolve the sulpho-cyanide; filter the solution thus obtained, and evaporate to dryness. The residue is to be dissolved in water, and tested with a persalt of iron. Putrefaction is not, therefore, it will be seen, necessarily an obstacle to the detection of the poison.

9. On the other hand, prussic acid, although the cause of death, may be entirely dissipated or decomposed, if the time that elapses between death and the analysis is considerable.

Casper mentions a case where it could not be found after twenty-six hours. Leuret and Lassaigne assert that if the body of an animal poisoned with prussic acid be left unburied, it cannot be detected after the third day; but that if it be buried within twenty-four hours after death, it may then be detected (if exhumed), after a longer period, but not later than the eighth day. But, on the other hand, the poison has been discovered by analysis five days after death ("Lancet," March 9, 1839, p. 882); seven days after death, the body having been all the time exposed to the air (Christison, p. 754); seventeen days after death (case of Montgomery); twenty-one days after death (Comtes-Rendus, No. 20, Nov. 13, 1854); and twenty-three days after death (Prov. Med. Jour., July 23, 1845). One of the authors in a case submitted to him obtained all the reactions of the poison nine days after death.

10. The viscera should be carefully preserved in well-stoppered bottles, as the acid with the greatest ease passes through corks, bladder, or paper. Further, there should be no delay in making the post-mortem, or in afterwards examining the contents of the stomach for the poison.

ESSENTIAL OIL OF BITTER ALMONDS.

(*Hydride of Benzoyl.*)

(Essence of Peach Nut Kernels—Peach Nut Oil.)

(The "Almond Flavour" of shops = 1 part of the oil diluted with seven parts of spirit.

The *bitter almond* (Amygdala amara) contains a glucoside called *amygdalin* ($C_{20}H_{27}NO_{11}$, $3H_2O$), a body not present in the *sweet almond* (Amygdala dulcis). An emulsion of two or three sweet almonds, when bruised and rubbed up with water, will be found to have no smell of "the essence of bitter almonds," whilst the odour will be at once noticed if two or three bitter almonds are treated in a similar manner.

In both bitter and sweet almonds there is a peculiar ferment present, called *emulsin* or *synaptase*, acting solely by its presence, neither giving or taking anything from the body on which it acts. It is the action of this body on the amygdalin that produces the peculiar almond essence, hydrocyanic acid and glucose. The reason, therefore, the almond odour is not formed with the sweet almond, is, that it contains no amygdalin.

$$\underbrace{C_{20}H_{27}NO_{11}}_{\text{Amygdalin.}} + \underbrace{2H_2O}_{\text{Water.}} \text{ and ferment} = \underbrace{C_7H_6O}_{\text{Hydride of Benzoyl.}} + \underbrace{HCN}_{\text{Prussic Acid.}} + \underbrace{C_6H_{12}O_6}_{\text{Glucose.}}.$$

One dram of the "oil of bitter almonds" may be obtained from about $1\frac{1}{4}$ to $1\frac{1}{2}$ lbs. of bitter almonds.

When a bitter almond is chewed, the poisonous principle is developed in the mouth and stomach. Bitter almonds, therefore, should not be eaten indiscriminately, and their sale to children should be forbidden. Seventeen grains of amygdalin will form under the influence of synaptase, 1 grain of anhydrous prussic acid (= 50 minims of Pharmacopœia acid.

The oil has a pale yellow amber colour. It is heavier than water (Sp. gr. 1·043), having a hot burning bitter taste, and producing a greasy stain on paper, not dissipated by heat. It is feebly acid. Water dissolves about $\frac{1}{30}$th part of the oil, but it is soluble both in ether and spirit in almost any proportion.

It is largely used in the kitchen for flavouring, but it is a dangerous article in the hands of careless cooks (who do too much by "rule of thumb," and too little by weight and measure). We have examined eight different samples of the oil, and find that the hydrocyanic acid present varies from 10 to 15 per cent., the amount being dependent in a great measure on the length of time that it has been kept. As a rule, the oil may be regarded as five to eight times the strength of the Pharmacopœia hydrocyanic acid, and is, therefore, a very deadly poison. No doubt, to a great extent (although in the experience of the authors, *not absolutely and completely*), it may be freed from the acid that it contains, but thus prepared it seems to decompose very rapidly, and to be readily converted by oxidation into benzoic acid. It may be mistaken by its smell and taste for nitro-benzole, which is itself poisonous.

Sulphuric acid produces with it a crimson red-coloured liquid, which changes, when exposed to the air, to yellow. If the crimson liquid be poured into water, the red colour disappears, and a yellow colouring matter falls to the bottom.

Symptoms.

The symptoms produced by the oil of bitter almonds are those essentially of hydrocyanic acid poisoning (page 454), but often superadded we find vomiting and symptoms of irritation. They ordinarily begin, too, somewhat later and last somewhat longer than those produced by hydrocyanic acid. Usually there are no convulsions, but paralysis, first of the voluntary, and then of the involuntary muscles, is common.

Twenty bitter almonds (Orfila) will kill a dog in six hours, if the gullet be tied, and six in four days if they be applied to a wound. Brodie found that 1 drop of the oil placed on the tongue of a cat, killed it in five minutes, with violent convulsions. Göppert found 5 drops killed a rabbit in six minutes. In our own experiments we found a small terrier died after taking 4 drops; whilst in another case a dog recovered after 10 drops had been administered. By prolonged exposure to the air, the poisonous activity of the oil is much diminished, and so much so, that in one case we found that 40 drops of such an oil produced no poisonous action on a dog whatsoever.

The experiments made by Dr. David Price with the essential oil are interesting, as illustrating how far the poisonous properties of the oil may be removed ("Lancet," Jan. 10, 1857, p. 47).

1. ʒj. of Langdale's purified essential oil was given to a large dog. Immediate intoxication was produced, but the animal recovered perfectly after fifteen minutes.
2. Four drops of the same oil was given to a rat. No action.
3. Four drops of the ordinary commercial oil was given to a rat. Convulsions and death occurred in six minutes and a half.
4. ʒss. of the purified oil was given to a cat. Immediate intoxication was produced, from which it recovered in four minutes.

As to its action on the human subject, Dr. Gregory asserts that if he takes one bitter almond, it causes a kind of intoxication and a nettle rash eruption. Wibmer mentions a case where a man eat half-an-ounce of bitter almonds, without any other effect than sickness and headache.

In the "London Medical and Physical Journal," lvii., p. 150, a case of death is recorded from eating a considerable quantity of bitter almonds.

As regards *dose*, 17 minims of the oil has destroyed life, but we are of opinion that a very much smaller quantity than this would prove fatal.

(For post-mortem appearances, treatment, &c., see Hydrocyanic Acid

Both the symptoms and the after-death appearances are similar to, though more intense, than those of pure prussic acid poisoning.)

We have only to remark in addition to what has been already stated under hydrocyanic acid, that the vapour tests with the oil act very slowly. In every case, therefore, distillation is essential for the recovery of the poison.

Bitter almond water, which is distilled from the cake after the oil is expressed, contains from 0·25 to 1·0 per cent. of prussic acid. It should therefore be used with some care.

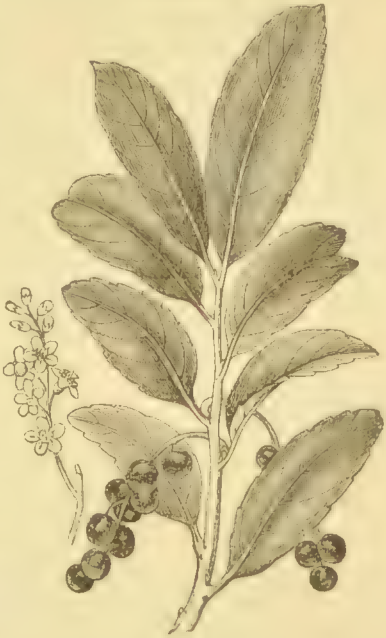
Prunus Lauro-Cerăsus. (Fig. 41.)

(Cherry Laurel.)

Nat. Ord : *Rosaceæ.*

The water prepared by distillation with the leaves of the cherry laurel is poisonous, owing to the prussic acid contained in the volatile oil. The oil generally contains about 2·75 per cent., and the water about 0·25 per cent. It is not, we believe, used so much now as formerly in confectionery. The leaves have been employed for flavouring custards, a proceeding not without danger, as all parts of the plant, except the pulp of the fruit, contain prussic acid. Several accidents have resulted from the practice of giving a bitter almond flavour to brandy by the addition of a small quantity of the oil of the cherry laurel. Even the leaves applied to a sore on the neck are said to have proved fatal. The young leaves contain about ten times as much oil as the old ones. The oil given to three rabbits in doses of 16 drops, killed them respectively in nine, fifteen, and twenty minutes, whilst 10 or 12 drops injected into the anus proved fatal in four minutes. Extravasation of blood into the trachea and lungs was found after death in each case.

FIG. 41.



The strength of *the distilled water* varies greatly. 1 oz. can be made to take up 3·25 grains of oil. It deteriorates greatly by keeping. Giddiness, palsy, insensibility, convulsions, coma, and death are induced, however it may be administered. One ounce has proved fatal, and severe symptoms have followed the administration of half-an-ounce.

The peach plant (Amygdalus persica), and more particularly its kernels and the young shoots, freely yield hydrocyanic acid. The peach blossoms have proved fatal in two cases (recorded by Coullon), once in an adult, and once in a child eighteen months old. In both cases there were convulsions and coma. The leaves are also poisonous, and have produced in one case serious results. The kernels are used as a flavouring for the eau-de-noyau.

The Mountain ash (Sorbus Acicuparia). The flowers, bark, and especially the root of this plant yield a distilled water containing hydrocyanic acid.

The bark, seeds, and leaves of the *cluster cherry* (Prunus Padus), yield a distilled water similarly poisonous. Half-an-ounce of the water will kill a dog. The fruit is also poisonous. The cake made from the kernels has been known to prove fatal to cows. The essential oil contains as much as 9·25 per cent. of hydrocyanic acid.

CYANIDE OF POTASSIUM (K Cy).

This is prepared by fusing together ferro-cyanide of potassium (K_4 Fe Cy_6), and carbonate of potash, in a crucible.

$$2\ K_2\ CO_3 + 2\ K_4\,Fe\,Cy_6 = 10\ KCy + 2\ KCy\ O + Fe_2 + 2\ CO_2.$$

The cyanide is used by photographers for dissolving the silver chloride, and for removing silver stains from the hands. It is largely used by electrotypers, by gold and silver lace cleaners, &c., and is the basis of some of the non-mercurial plate-powders.

It has a similar odour to that of prussic acid, and is a white deliquescent crystalline body. It is very soluble in water, the solution being clear, colourless, and very alkaline. It is also soluble in alcohol. It is decomposed by all acids, prussic acid being set free. The white precipitate produced by nitrate of silver with chlorides, &c., is soluble in an excess of potassic cyanide. It is a deadly poison; 5 grains has destroyed life in twenty minutes, but this is by no means the smallest dose that would prove fatal. Two grains will kill a dog in eight hours. It is a dangerous drug to apply to the skin, because of the local chemical action it induces.

As regards tests, symptoms, and post-mortem appearances, see Hydrocyanic Acid.

Respecting the action of *Cyanide of Mercury* (Hg Cy^2) (*Vide* page 216).

It may be advisable here to say a few words respecting the action of *cyanide of silver*, and of "*the silver solution*" which consists of cyanide of silver dissolved in cyanide of potassium.

The action of cyanide of silver has been investigated by Dr. Letheby ("Medical Gazette," N. S. vol. i., and "Medical Times and Gazette," July 12, 1851, p. 43). He finds if the cyanide be *dried* before administration that it acts simply as a local irritant, producing vomiting and a congested state of the vessels of the stomach. But if it be administered in a *moist* state, then it is rapidly absorbed and produces the ordinary effects of prussic acid. Sometimes it causes convulsions, more generally paralysis, and always profound coma. The action of the heart becomes irregular, death taking place by a gradual exhaustion of the involuntary acts, respiration ceasing first.

As 1 grain of anhydrous prussic acid is sufficient to cause death, it may be supposed that its equivalent in the silver salt would also be sufficient, but of this we have no definite information.

A solution of cyanide of silver in cyanide of potassium has more than once caused death. It is used by the counterfeit coiners ("smashers"), in order to obtain a silver coating. The solution is usually as limpid and as colourless as water. The analysis of two samples of this solution gave as follows:—

Specific Gravity	1074	1115
Reaction	very alkaline	
Total Solid per Cent.	12·5	18·6
Carbonate of Potash	5·87	10·86
Cyanide of Potassium	5·03	6·34
Cyanide of Silver	1·60	1·40

Zinc and copper readily decompose the solution and become coated with a layer of silver.

The symptoms produced by the liquid, so far as they have been observed, seem to differ somewhat from those induced by the action of pure hydrocyanic acid, or by cyanide of silver. It does not usually produce vomiting or convulsions, but it occasions paralysis, a prostration of all the vital powers, and death by coma. The post-mortem shows that the arrest of the circulation takes place in the lungs, for they are found after death to be highly congested, the bronchial tubes and pulmonary cells being filled with a frothy mucus, whilst the right side of the heart is gorged with black fluid blood and the left side empty (Dr. Letheby).

The "non-mercurial" plate-powders are often composed of cyanide of silver, with whiting, or some similar admixture.

Ferrocyanide of potassium (yellow prussiate of potash), ($K_4\ Fe\ Cy_6$ or $K_4\ Fe\ C_6\ N_6 + 3\ H_2\ O$), is prepared by heating nitrogenous animal refuse, such as the scrapings of horns and hoofs, with iron filings and potashes. The mass is afterwards boiled with water, filtered, and the solution allowed to stand for crystals of the salt to form.

The ferrocyanides are not poisonous, or at most but very feebly so. Gazan and Callies assert that two or three drams will kill a dog, but this has been proved to be an error. Scubarth gave ½ oz., and D'Arcet ½ lb. to animals without any other effect being produced than a mild laxative action.

SULPHOCYANIC ACID ($H\ Cy\ S$).

Sulphocyanide of Potassium ($K\ Cy\ S$).

Sulphocyanide of potassium is prepared by boiling together pure cyanide of potassium and sulphur. It is not a very active poison.

Mayer found that 90 grains killed a rabbit in four hours, and in another case, that a rabbit died from ʒiss. of a strong solution after ninety seconds. There were no convulsions. In other cases he found rabbits take ʒiij. without any injurious effect.

The appearances found after death were similar to those produced by the action of an irritant poison.

Westrumb found 40 grains killed one dog in seven minutes, and another in two hours, convulsions being the prominent symptom. The poison was afterwards found in the blood, lungs, liver, spleen, and kidneys.

Soemering asserts it to be an active poison. He found that 30 grains of the potash salt killed a dog in one minute, and that ʒss. of a concentrated sulphocyanic acid solution proved fatal almost instantaneously.

Tests.

1. *A ferric salt*, such as a solution of *persulphate of iron*, produces with sulphocyanic acid or with the sulphocyanides a blood-red coloured liquid. A similar reaction occurs when an iron salt is added to meconic acid, but—

(*a*) The red colour *with sulphocyanides* is discharged on adding corrosive sublimate, and is not discharged on adding hydrochloric acid; whilst—

(*β*) The red colour *with meconic acid* is not discharged on adding corrosive sublimate, and is discharged on adding hydrochloric acid.

2. Having produced the red sulphocyanide of iron, acidulate the coloured solution with hydrochloric acid, and add a piece of zinc, when sulphuretted hydrogen will be produced and the liquid become bleached.

The toys called "Pharoah's Serpents," consist simply of *sulphocyanide of mercury* ($Hg\ Cy_2\ S_2$). These playthings ignite easily, and are dangerous from the fact that the vapour of metallic mercury is given off, together with mercuric sulphide, nitrogen, carbonic and sulphurous acid gases, a light solid material being left (melonide of mercury), which forms the remarkable snake-like coil. They require care in their use.

A case of poisoning by swallowing one of the little cones of the sulphocyanide of mercury is recorded.

Cyanic acid ($H\ Cy\ O$ or $H\ C\ N\ O$), is a monobasic acid. It forms salts called *cyanates.* Hünefeld states that neither the acid nor its salts are poisonous.

Cases of Poisoning with Prussic Acid, &c.

(I.) PRUSSIC ACID.

1.

"Revue Médicale," Feb. 1845, vol. i., p. 265. Male: adult. Took ʒj of Scheele's Acid in the morning without effect; a second ʒj after dinner without effect; a third ʒj of Vauquelin's Acid was afterwards taken; and a few seconds afterwards another ʒj of the same acid.

Symptoms.—After the last dose walked a few steps, and then fell down senseless; teeth perfectly closed; violent convulsions; consciousness returned in 2½ hours; for 4 days very little water was passed. Recovered in 13 days.	*Result.*—Recovery.	

2.

Guy's "Forensic Medicine," (Dr. Guy); "Medical Times," Nov. 22, 1845, p. 169. Male: æt. 19. A mouthful of Pharmacopœia acid.

Symptoms.—After taking the poison got out of bed, walked 2 or 3 yards, put the stopper in the bottle, and walked back to the bed again, and then became senselss; for 3 hours there was gasping respiration; the jaws rigid; the pupils dilated; in 6 hours sensibility returned, and he drank freely; vomiting was then induced; the fæces and urine were involuntarily expelled.	*Result.*—Recovery.	

3.

"Lancet," Jan. 14, 1854 (Mr. Burman). Male: æt. 60. ʒj = 2·4 anhydrous acid.

Symptoms.—Took in a few seconds ʒss of sp. ammoniæ comp., whilst in 4 minutes afterwards cold affusion was administered; vomiting and convulsions were succeeded by insensibility, which passed off in 20 minutes; the insensibility did not come on for 2 minutes; 35 minutes after taking the poison he walked upstairs.	*Result.*—Recovery.	

4.

"Edinburgh Monthly Journal," Feb. 1850, p. 97 (Sir Robert Christison). A dose of acid. = 1·5 anhydrous acid.

Treatment.—(Stomach-pump; cold affusion.)	*Result.* — Recovery in 3 hours, with great disposition to sleep.	

5.

"Provincial Medical and Surgical Journal," p. 517, Aug. 13, 1845 (Mr. Bishop); and "Lancet," Sept. 20, 1845. Male: æt. 40. 40m. of acid (3·25 per cent.) = 1·33 of anhydrous acid.

Symptoms.—Remained sensible for 2 minutes, and was able during this time to give an account of his feelings; face pale, but swollen; conscious even to remembering his jaws getting tight and stiff; (cold douche was employed, with emetics, ammonia, and bleeding).	*Result.*—Recovery.	

6.

"Medical Gazette," vol. xxxvi., p. 103 (Mr. T. Taylor). Male. 20m. Scheeles' acid = 0·9 anhydrous acid.

Symptoms.—Remained insensible for 4 hours. Vomiting.—Vomited matters had no odour of the poison.	*Result.*—Recovery.	

7.

"Lancet," June 7, 1845, p. 638 (Dr. Letheby); also July 26, 1845 (Dr. Letheby and Mr. Hicks).

Symptoms.—When the poison was taken, the patient was sitting in a chair; she then jumped up, ran a short distance, and then fell down; and became at once insensible and violently convulsed; the limbs became fixed in tetanic spasm; the face swollen and purple; the jaws clenched; foam at the mouth; eyes glistening; pupils widely dilated, and insensible to light; low muttering. Death in 20 minutes; there was no scream.	*Result.*—Death.	*Post-mortem.*—At the post-mortem, 4 days after death, the limbs were still rigid and extended, and the jaws fixed; the vessels on the surface and in the brain were full of black fluid blood; the odour of prussic acid was noticed when the chest was opened, and particularly in the fluid of the pericardium; lungs congested; the stomach was healthy, except one small red patch; the contents smelt decidedly of the acid, but the reactions produced were only slight.

8.

"Christison," p. 764 (Hufeland). Male: adult. Dose. = 40·0 grains of pure acid.

Symptoms.—Staggered for a few steps, and then sank down without a groan; after a short interval, made a forcible expiration, and after several convulsive respirations, died in 5 minutes after swallowing the poison.	*Result.*—Death.	*Post-mortem.*—Countenance composed and calm; blood fluid, exhaling a smell of prussic acid; vessels of brain gorged; liver gorged; stomach and intestines red and softened; lungs turgid; left side of the heart empty.

9.

"Lancet," June 7, 1845, p. 640 (Mr. Leithead). Female: æt. 17. ℥j of acid (?).

Symptoms.—The facts show that she swallowed the acid, then recorked the bottle, thrust the bottle at full arm's length between the feather bed and mattrass, laid down again and drew the clothes over her; there was no stertor or convulsions. Death in 4 or 5 minutes.	*Result.*—Death.	*Post-mortem.*—Mr. Leithead smelt the acid as he entered the room 14 hours after death, where the body of the girl was lying.

10.

"Medical Gazette," April 4, 1845; "Lancet," Feb. 15, 1845, p. 196 (case of Mr. D. S. Holmes) (Mr. Pooley). Male: adult. A little less than ℥ss of Scheeles' acid.

Symptoms.—Death in about 10 minutes: there was no scream, or convulsions. He corked the bottle after taking the poison.	*Result.*—Death.	*Post-mortem.*—Post-mortem 22 hours after death. Blood everywhere dark coloured and fluid; smell of prussic acid in the stomach distinct, but none in the brain, or heart; stomach healthy; vessels of brain gorged.

11.

"Boston Medical and Surgical Journal," vol. xxxvii., p. 322. Male: adult. ʒvii of Scheeles' acid = 21·0 grains of anhydrous acid.

Symptoms.—After taking it he walked to the door of his room, unlocked it, and then walked back again to the sofa, and stretched himself upon it.	*Result.*—Death.	

12.

Taylor "On Poisons," p. 646. Male: æt. 44. ℥ss (?).

Symptoms.—After taking it, walked about ten steps, went down a flight of seventeen stairs, then went to a druggist's shop forty-five paces distant; asked for some more poison, and at that moment dropped down insensible, and died in from 5 to 10 minutes.	*Result.*—Death.	

13.

"Medical Gazette," vol. viii., p. 759. Female. Probably ʒivss of the acid.

Symptoms.—Found dead. The circumstances prove that the girl had corked the bottle, wrapped it up in paper, and adjusted the bed clothes after taking the poison.	*Result.*—Death.	

14.

Taylor's "Medical Jurisprudence." vol. i., p. 363 (Mr. French). Male. ʒvii of common prussic acid.

Symptoms.—Survived for 4 or 5 minutes; was seen 2 minutes after taking the poison, when he was quite insensible; no true convulsions, but convulsive fits of breathing, expiration being very deep.	*Result.*—Death in 4 or 5 minutes.	

15.

"Medical Times," June 6, 1846, p. 196 (Mr. Ilott). Female: æt. 23. Considerable quantity.

Symptoms.—Found dead.	*Result.*—Death.	*Post-mortem.*—Clothes not disarranged: brain healthy; stomach somewhat inflamed; prussic acid found (Dr. Leeson).

16.

Taylor's "Medical Jurisprudence," vol. i, p. 364 (Dr. Geoghegan). Male: æt. 30. Large dose.

Symptoms.—Found dead in his bed.	*Result.*—Death.	*Post-mortem.*—In 5 hours after death rigidity commenced; face pale; eyes half closed—not glistening; pupils dilated; no froth at the mouth; abdomen, when opened, smelt strongly of the acid—the smell was well marked in the stomach; mucous membrane of stomach very congested.

17.

Taylor's "Medical Jurisprudence," vol. i., p. 364 (Mr. Blaker, Lewes). Male: adult. ʒj of strong acid.

Symptoms.—Found after 30 seconds in a state of collapse, breathing heavily.	*Result.*—Death in 20 minutes.	*Post-mortem.*—Great congestion of the coats of the stomach towards the cardiac end; intestines highly congested; membranes of the brain not congested.

18.

"Lancet," March 24, 1866, p. 310 (Dr. Hickman); and "Medical Times and Gazette," March 3, 1866, p. 235. Male: æt. 40. 3·5 grains of anhydrous acid, or ½ oz. of an acid containing 1·48 per cent.

Symptoms.—After taking it, replaced the bottle, shut the door, ran up seventeen stairs and across a long landing, afterwards up a second flight of eighteen stairs, and was then able to stand and ask for assistance. Death occurred in 10 minutes without convulsions.	*Result.*—Death in 10 minutes.	*Post-mortem.*—Post-mortem in 30 hours. Pupils dilated; no odour of the poison at the mouth; all the organs congested; left cardiac ventricle very contracted and empty; the right side full of dark fluid blood; blood everywhere fluid; mucous membrane of the stomach reddened, and the stomach itself contracted; no odour noticeable except just when the stomach was opened.

19.

"Lancet," Nov. 2, 1861, p. 419 (Dr. Lawrence Gill). Male: adult. Probably about ℥j.

Symptoms.—No scream ' heard; no froth from the mouth, and no indication of convulsions; no smell of the acid at the mouth after 1½ hours.	*Result.*—Death.	

20.

"Medical Times and Gazette," Oct. 22, 1864, p. 434 (Mr. Griffin). Male: æt. 59. (?).

	Result.—Death.	*Post-mortem.*—Found dead. No smell of prussic acid detected in the mouth; the bottle was found in another room to that in which the man was found dead; stomach a deep red colour; prussic acid found.

21.

"Lancet," Jan. 1864, p. 52 (Dr. Griffith). Male: adult. ℥j of Scheeles' acid.

Symptoms.—After taking it, he walked to his bed, passed water, got into bed and partially covered himself with the clothes.	*Result.*—Death.	*Post-mortem.*—Slight congestion of the stomach at the greater curvature. It smelt, after 8 days, of the poison.

22.

"Lancet," Sept. 14, 1844, p. 751 (Mr. Crisp, Walworth). Male: æt. 42. Quantity doubtful—probably a large quantity.

	Result.—Death.	*Post-mortem.*—Post-mortem 48 hours after death. No odour detected.

23.

"Lancet," Dec. 14, 1844, p. 336 (Dr. Letheby). (Case of Duckett and Miss Williams.)
2 cases. Male: æt. 21; female: æt. 27. Each about ʒj.

	Result.—Death.	*Post-mortem.*—Post-mortem after 12 hours. Found after death with their arms arranged round each other; the clothes not being in the slightest degree disarranged; hence no convulsions had probably occurred; blood of both was dark, fluid, and smelt of the poison; stomach partially congested, with occasional white patches and red dots.

24.

"Lancet," April 5, 1845, p. 379 (case of Tawell, tried for the murder of Sarah Hart).
Female. (?)

Symptoms.—Eyes brilliant; pupils dilated.	*Result.*—Death.	*Post-mortem.*—Slight venous congestion of lung; some doubt about whether there was any smell of the poison at the post-mortem 18 hours after death.

25.

"Lancet," Sept. 14, 1844, p. 751 (Mr. Crisp). Male: æt. 42. Probably ʒij.

Symptoms.—After taking it, put the tumbler in the *pôt de chambre*, pushed it under the bed, and turned himself on his left side.	*Result.*—Death.	*Post-mortem.* — Bloody serum issued from the mouth; veins on the arm were distended with purple blood; and crimson spots found on various parts of the body; doubt about the presence of any odour (post-mortem 70 hours after death).

26.

"Lancet," Oct. 11, 1873, p. 522 (Mr. J. Howell Thomas). Male: æt. 44. ʒj Pharm. acid.

Symptoms.—No tetanic convulsions, nor discharge of urine or fæces; no cry before death; pupils dilated. Death in 35 or 40 minutes.	*Result.*—Death.	*Post-mortem.*—Smell of acid noticed in brain; lungs gorged with liquid blood; heart empty; no smell of acid in heart or lungs; patches of congestion in the stomach, duodenum, and ileum; faint odour of the acid in liver, kidneys, and spleen; blood everywhere fluid (post-mortem 22 hours after death).

(II.) OIL OF BITTER ALMONDS.

27.

"Lancet," Dec. 6, 1845, p. 612 (Mr. Hetley). Female: æt. 21. Two pennyworth (?).

Symptoms.—Countenance livid, apparent intoxication passing into insensibility; pupils contracted. (The stomach-pump was used); bladder and bowels acted involuntarily; she afterwards roused up, when the pupils became dilated; numbness in legs and arms set in, and coma continued for some time, but she eventually recovered.	*Result.*—Recovery.	

28.

"Lancet," Sept. 21, 1839, p. 930 (Mr. P. H. Chavasse). Male: adult. ʒss of oil.

Symptoms.—Became insensible in half a minute; vomiting occurred in a few minutes with delirium and convulsions.	*Result.*—Recovery.	

29.

"Lancet," June 8, 1844, p. 335 (Mr. Smith of Clifton). Female: æt. 8. Essence ʒj. (= oil. 1 to 8 spirit) = 7 drops of the oil taken.

Symptoms.—Almost immediate pulselessness; jaw became firmly clenched; dilated pupils; the eyes brilliant; insensibility.	*Result.*—Recovery.	

30.

"British Medical Journal," Aug. 15, 1868, p. 167 (Mr. Shorts). Female: æt. 3. A tablespoonful.

Symptoms.—Foaming at mouth; pupils dilated and fixed; drowsiness. (Emetics, cold douche, and galvanism used.)	*Result.*—Recovery.	

31.

"British Medical Journal," Dec. 21, 1861, p. 655 (Dr. Barker). Male: æt. 6. Two teaspoonfuls.

Symptoms.—Pupils dilated; eyes brilliant and glassy. (Cold affusion and stimulants given.)	*Result.*—Recovery.	

32.

"Lancet," Jan. 13, 1855 (Mr. Purcell). Male: æt 4. ʒiv or ʒv of the oil of bitter almonds (concentrated).

Symptoms.—After taking it, he ran up stairs, and on reaching the passage fell down insensible; he was then carried to the doctor, a distance of about 100 yards. His eyes then seemed to be almost protruding from their sockets: there was complete opisthotonos and tetanic spasms. (Stomach-pump, emetics, cold affusion.) Recovery in 2½ hours.	*Result.*—Recovery.	

33.

Taylor's "Medical Jurisprudence," vol. i., p. 371 (Dr. Bull, Hereford); "Provincial Medical Journal," Sept. 11, 1844, p. 364. Female: æt. 49. 17m. of essential oil.

Symptoms.—In 15 minutes symptoms set in, with strong convulsions. (Stomach-pump was used); insensibility: frothing at mouth, and dilated pupils.	*Result.*—Death in 30 minutes.	*Post-mortem.*—Bitter almond smell perceptible in the *stomach* nine hours after death, but not in the chest, head, or heart; brain congested, with effusion of serum in ventricles; mucous membrane of the stomach congested.

34.

Taylor's "Medical Jurisprudence," vol. i. p. 371. Male: æt. 13. A quantity. (?)

Symptoms.—No convulsions; there was insensibility and dilated pupils.	*Result.*—Death in 15 minutes.	*Post-mortem.*—Odour of poison detected in the stomach; the mucous membrane of the stomach was pale, with ecchymosed spots.

35.

Taylor's "Medical Jurisprudence," vol. i. p. 371. Male: æt. 20. ℥ij.

Symptoms.—Fell down suddenly in the act of swallowing; made a loud cry; gave one deep expiration, and died.	*Result.*—Death instantaneously.	

36.

Taylor's "Medical Jurisprudence," vol. i. p. 371. Female: æt. 46. m. xxx. of the oil.

Symptoms.—Insensibility set in in 10 minutes; pupils dilated; frothy mucus at the mouth; lower jaw contracted; breathed slowly and heavily; odour of bitter almonds perceived in the breath; some blood drawn from the arm was found thick and dark.	*Result.*—Death in 30 minutes.	

37.

Taylor's "Medical Jurisprudence," vol. i., p. 372. Female: æt. 39. ʒss of essential oil.

Symptoms.—In 10 minutes she was found senseless and motionless; pupils dilated; breathing stertorous; no convulsions.	*Result.*—Death in 30 minutes.	

38.

"Lancet," Dec. 13, 1845, p. 656. Male: æt. 19. ʒij of the oil.

Symptoms.—Dilated pupils; death in 3 hours.	*Result.*—Death.	*Post-mortem.*—Brain and lungs gorged; heart filled with fluid blood; the stomach on being opened smelt strongly of bitter almonds.

39.

"Journal Complémentaire," vol. xvii., p. 366; "Christison," p. 786 (Metzdorff). Male: æt. 48. ʒij of the oil.

Symptoms.—In a few minutes was found to be in spasms; and in 20 minutes was quite insensible; pupils immoveable; breathing stertorous, and the odour of the poison distinct.	*Result.*—Death in 30 minutes.	*Post-mortem.*—Putrefaction rapid, blood fluid; veins everywhere turgid; stomach and intestines very red.

40.

"London Medical and Physical Journal," vol. lvii., p. 150; "Christison," p. 786 (Mr. Kennedy). Male: adult. Ate a quantity of bitter almonds.

Symptoms.—Dropped down suddenly, and found to be insensible; imperceptible pulse, the breath smelling of the poison.	*Result.*—Death.	

41.

"Lancet," March 10, 1866, p. 255 (Dr. Barclay). Male: æt. 57. ʒij of the oil taken 1 hour after breakfast.

Symptoms.—In 20 minutes he was found speechless; pupils dilated; (the stomach pump was used, and emetics given;) in 40 minutes after the stomach-pump had been used he rallied; 35 minutes afterwards vomiting occurred, and tetanic convulsions set in; motions passed involuntarily; breathing became spasmodic. Died in 3 hours.	*Result.*—Death in 3 hours.	*Post-mortem.*—Post-mortem in 24 hours. Dark fluid blood in scalp; brain smelt of prussic acid; mucous membrane of the stomach congested, and smelt strongly of the poison; blood fluid, excepting a clot in the right ventricle of the heart.

42.

"Pharmaceutical Journal," May, 1859, p. 583. Æt. 15 months. The essential oil given instead of the oil of almonds.

	Result.—Death in a ¼ of an hour.	

43.

"Pharmaceutical Journal," Jan. 1860, p. 389. Æt. 9 months. Small dose.

	Result.—Death in ¾ of an hour.	

44.

"Lancet," Dec. 1, 1849, p. 575 (Mr. Iliff). Female: æt. 24.

Symptoms.—Found dead; bottle replaced in pocket.	*Result.*—Death.	*Post-mortem.*—Pupils dilated; smell of the poison at the mouth, and on opening the abdomen, very distinct.

45.

"Medical Times and Gazette," Dec. 15, 1855, p. 609 (Dr. Quain). Male: æt. 37. ʒx (each dram contained 3·12 anhydrous prussic acid).

Symptoms.—After taking it, walked down stairs.	*Result.*—Death in 10 minutes.	*Post-mortem.*—Œsophagus normal; stomach of a chocolate-brown colour.

(III.) CYANIDE OF POTASSIUM.

46.

Taylor's "Medical Jurisprudence," vol. i., p 370 (Dr. Taafe). Male. A little less than 1 oz.

Symptoms.—Insensibility and sterterous breathing came on in a few minutes; (stomach-pump and cold affusion was used in 10 minutes after the poison was taken;) vomiting in 2 hours.	*Result.*—Recovery.	

47.

"Christison," p. 771. Gr. vj used as injection.

Symptoms.—Convulsions; palpitation; dilated pupils, and death in 1 hour.	*Result.*—Death.	

48.

"Tardieu sur l'Empoisonnement," p. 1034. A little piece of the cyanide got under the nail of a photographer, to which he afterwards applied vinegar.

Symptoms.—No loss of consciousness; but severe symptoms.	*Result.*—Recovery.	

49.

"British and Foreign Medical Review," 1857, vol. 19, p. 498; and "Boston Medical and Surgical Journal," Dec. 11, 1856. Seven grains.

Symptoms.—Immediate pain and soon after unconsciousness; no convulsions, but a sudden convulsive action of the body took place after the heart had ceased to beat.	*Result.*—Death in 1 hour.	

50.

Taylor's "Medical Jurisprudence," vol. i. p. 369. Female. Five grains.

Symptoms.—Unconsciousness in 2 minutes; convulsions; dilated pupils; foaming at mouth; tetanus; (stomach-pump was used 5 minutes after the poison had been taken).	*Result.*—Death in 20 minutes.	

51.

"Medical Times and Gazette," Oct. 12, 1850, p. 390 (Dr. Ross). Female: æt. 30. Quantity (?).

Symptoms.—Found dead, kneeling at the side of the bed; involuntary passing of urine and fæces; tetanus and opisthotonos had apparently occurred.	*Result.*—Death.	*Post-mortem.*—Post-mortem on third day. Lungs congested; stomach very red, prussic acid found in analysis; blood fluid.

52.

"Medical Times and Gazette," Nov. 9, 1850, p. 482. (Dr. Hinds). A large dose. Man a drunkard.

Symptoms.—No signs of convulsions; froth issued from the nose; hands not clenched; pupils dilated.	*Result.*—Death in less than 1 hour.	*Post-mortem.*—Countenance natural; features placid; brain pale; lungs congested; heart empty; blood fluid; stomach inflamed, and smelt of the poison.

53.

Taylor's "Medical Jurisprudence," vol. i. p. 370. Female: æt. 18. Dose (?).

Symptoms.—Vomiting; insensibility; pulselessness in 20 minutes; (artificial respiration and cold affusion were tried).	*Result.*—Death in 30 minutes.	*Post-mortem.*—Mucous membrane of stomach injected; no corrosion about the mouth; all organs healthy; contents of stomach had an almond odour; prussic acid was found on analysis.

54.

"British Medical Journal," Nov. 2, 1861, p. 475 (Mr. Byerley). Male: æt. 46. Quantity (?).

Symptoms.—?	*Result.*—Death.	*Post-mortem.*—Lips distorted, as if by convulsions; liver, spleen, lungs, and kidneys congested; heart empty; stomach very congested, empty, and contracted; odour well marked.

(IV.) CYANIDE OF POTASSIUM AND CYANIDE OF SILVER.

55.

"Medical Times and Gazette," July 12, 1851, p. 41 (Dr. Letheby). Female. Silver solution (Cyanide of silver in cyanide of potassium, used for coating counterfeit money).

Symptoms.—Appeared as if intoxicated; loss of voluntary motion; rapid insensibility; no sickness or convulsions.	*Result.*—Death in 40 minutes.	*Post-mortem.*—Post-mortem in 32 hours. Countenance composed; eyes glistening; pupils dilated; jaws firmly clenched; rigor mortis very strong; membranes of brain much congested; right side of heart full of uncoagulated blood; bladder empty; stomach red; smell of prussic acid distinct.

56.

"Medical Times and Gazette," July 12, 1851, p. 41 (Dr. Letheby). Female: æt. 24. ʒiv of the above silver solution.

Symptoms.—Sudden insensibility; convulsions; foam from mouth.	*Result.*—Death in 10 minutes.	*Post-mortem.*—Post-mortem in 40 hours. Mouth covered with foam; vessels of the brain gorged with blood; lungs and stomach congested

(V.) LAUREL WATER.

57.

"Case of Sir Theodosius Boughton" (trial of Donellan) Beck's "Medical Jurisprudence," p. 894). Male: æt. 20. A draught (?).

Symptoms.—Insensibility in 15 minutes; teeth locked; froth from mouth; eyes fixed.	*Result.*—Death in 30 minutes.	*Post-mortem.*—Great venous congestion everywhere; stomach very red.

58.

Coullon's "Recherches," p. 95.

Symptoms.—A child died from the effects of laurel leaves applied to a large sore on the neck.	*Result.*—Death.	

59.

Coullon's "Recherches," vol. xxxvii., p. 84. Two persons drank some of the water.

Symptoms.—In one case, three spoonfuls were swallowed. Death in one case occurred in 1 hour, and in the second, in a few minutes. No convulsions in either case.	*Result.*—Death.	

60.

Foderé, vol. iv., p. 27. Two persons swallowed several mouthfuls each of the water.

Symptoms.—Both died almost instantly in convulsions.		

61.

Hufeland's "Journal der Praktischen Heilkunde," Feb. 1813 (Dr. Hayn). Male: old. ℥iss of cherry laurel water.

Symptoms.—After 3 hours became paralysed in hands and feet, but did not lose sensation; mental faculties clear to the last; at length the respiratory muscles became affected, and he then died.	*Result.*—Death.	

(VI.) CHERRY KERNELS.

62.

"Medical Times," May 17, 1845, p. 123. Female: æt. 5. The kernels of some stones of the sweet cherry.

Symptoms.—Intense coma; eyes closed; pupils dilated; respiration hurried; urine and fæces involuntarily discharged; convulsions.	*Result.*—Death in 40 hours.	*Post-mortem.*—Stomach reddened.

See other Cases of Poisoning by

(I.) PRUSSIC ACID,

"Edinburgh Medical and Surgical Journal," vol. xlviii., p. 44 (Dr. Banks). (Recovery after 30 minutes.

Ranking's "Half-yearly Abstract," vol. ii., p. 399.

"Medical Times and Gazette," Jan. 9, 1858, p. 36. (Case of Agnes Montgomery—Englesham Case.)

"Edinburgh Monthly Journal," Feb. 1850, p. 97.

"Medical Gazette," vol. xxxv., p. 859.

(II.) OIL OF BITTER ALMONDS.

"Lancet," Oct. 17, 1863, p. 44 (Mr. Phillips).

(III.) CYANIDE OF POTASSIUM.

"Chemical News," Sept. 5, 1863, and April 27, 1861, p. 260.

"Medical Times and Gazette," July 12, 1851, p. 41.

"Lancet," Oct. 17, 1863, p. 447, and vol. i., 1871, p. 806.

(IV.) LAUREL WATER.

"Philosophical Transactions," 1739, p. 452.

CHAPTER XIV.

Vegetable Acids.

Acetic acid—*Citric acid*—*Oxalic acid*—Properties of—*Binoxalate of potash*—Symptoms and Tests—Toxicological analysis—Stains on cloth—*Pyrogallic acid*—*Tartaric acid.*

ACETIC ACID ($HC_2 H_3 O_2 = 60$).

Acetic Anhydride ($C_4 H_6 O_3$).

The destructive distillation of wood, or the spontaneous oxidation of the alcohol of wine as carried out in Germany, or the similar process with malt solution as adopted in England, are the common sources of acetic acid. Vinegar ordinarily contains about 5 per cent. of acetic acid. The Pharmacopœia acetic acid contains 33 per cent. of real acid, and 28 of acetic anhydride.

Acetic acid is an irritant poison. One oz. of the strong acid has killed a dog in an hour and a quarter, whilst 4 or 5 ozs. of vinegar has caused death in times varying from ten to fifteen hours. The stomach has been found perforated. In the human subject death has occurred after six hours. Recovery is recorded after 2 or 3 ozs. of acetic acid taken by a man in a state of intoxication. Convulsions and salivation are stated to have occurred in some cases of poisoning.

Tests.

The tests for acetic acid and for the acetates are as follows :—

(1) On heating an acetate with sulphuric acid, free acetic acid, which may be recognized by its odour, is evolved.

(2) If a few drops of spirit be added before the application of heat, acetic ether (acetate of ethyl) is given off, which may be known by its peculiar apple odour.

(3) If the solution of the acetate be neutralized, and a few drops of a neutral solution of perchloride of iron added, a deep red liquid will be produced. (Ferric acetate.)

(4) Acetic acid reddens litmus, even when in great dilution.

Toxicological Analysis.

In a medico-legal examination it must be remembered that some observers (Tiedemann, Gmelin, Leuret, and Laissagne) have asserted that acetic acid is a natural secretion of the stomach. Something more than a mere trace of the acid therefore should be discovered, in order to be able to sustain a criminal charge. Proceed as follows :—

Distil the contents of the stomach to dryness. Test the distillate, to see whether any sulphuric or hydrochloric acids be present. If not, neutralize with carbonate of potash, and evaporate to dryness. Add a small quantity of sulphuric acid to the residue, and re-distil; in this manner a solution of the pure acid will be obtained, and may be tested accordingly.

Cases of Poisoning with Acetic Acid.

1.		
Orfila, "Toxicologie," vol. ii., p. 198. Female: æt. 19. Pregnant 2½ months.		
Symptoms.—Found dying on the highway; convulsions; pain in the stomach.	*Result.*—Death in about 6 hours.	*Post-mortem.*—No softening or corrosion of the stomach, but the mucous membrane near the pylorus was almost black; the mucous glands prominent, and the vessels filled with dark coagulated blood; the stomach contained 6 ozs. of a thick blackish fluid; intestines healthy.
2.		
"Lancet," July 27, 1867, p. 98 (Mr. Birkett). Male: æt. 40. Two or three ozs. of acid taken when intoxicated. (33 per cent. of anhydrous acetic acid.)		
Symptoms.—Consciousness, but very great anxiety; no pain, but difficult breathing from acute laryngitis; neither the tongue nor lips were charred or inflamed; tracheotomy had to be performed; salivation on the second day: on the 3rd day the tracheotomy tube was removed; recovered in 3 weeks.	*Result.*—Recovery.	
3.		
"Medical Times," Sep. 13, 1865, p. 471. Male: æt. 36. A teaspoonful of aromatic vinegar.		
Symptoms.—Instant and excruciating pain; mouth became white; great sickness; (milk and carbonate of magnesia given).	*Result.*—Recovery.	

CITRIC ACID ($H_3 C_6 H_5 O_7 H_2 O = 210$).

This acid is found in colourless crystals, soluble in half their weight of boiling, and in three-fourths their weight of cold water. At a temperature of 100° C. (212° F.) the citrates when heated with sulphuric acid give off carbonic oxide; carbonic acid and acetone being produced at a higher temperature.

Citric acid is believed to be a more active poison than tartaric acid. The treatment in cases of poisoning will be similar.

Case of Poisoning with Lemons.

1.		
"Lancet," Nov. 24, 1860, p. 508 (Dr. Farre). Male: æt. 3. Female: æt. 5. Two lemons eaten by the girl, and 1 or 1½ by the boy.		
Symptoms.—Symptoms of prostration; collapse; insensibility; lividity of face; absence of pulse; extreme prostration.	*Result.*—Recovery.	

OXALIC ACID ($H_2 C_2 O_4 2 H_2 O$) = 126.

(Acid of sugar.)

Oxalates are found in the juices of several plants, such as rhubarb, common dock, wood-sorrel, &c. Upon a small scale oxalic acid is manufactured commercially by boiling nitric acid with loaf sugar, and upon a large one by roasting sawdust with alkalies. The sodium oxalate thus formed is decomposed by lime, an oxalate of calcium being in this way produced. This is digested with sulphuric acid, when the oxalic acid is set free, and purified by successive crystallizations.

Oxalates are met with in the urine in considerable quantity in certain diseased conditions, although even in healthy urine, according to most observers, a minute trace may always be found.

Oxalic acid is used very largely in various manufactures and trades, such as that of bookbinders, leather and straw workers, brass workers, &c., by whom it is known as "acid of sugar." It is also commonly used to remove ink stains.

Frequent accidents have occurred from its having been mistaken for Epsom salts and for sulphate of zinc, to both of which it bears some resemblance. It is rarely used for the purpose of committing murder, but not unfrequently by the suicide. Most of the deaths, however, recorded by it have been accidental.

Could a poisonous dose of oxalic acid be administered to a person against his will, and unbeknown to him?

Dr. Thudichum (" Medical Times and Gazette," April 21, 1860, p. 391) holds that this is impossible, inasmuch as he considers that a quantity of acid not greater than 10 grains in a pint of gruel may be easily detected by the taste. The experiments of Dr. Thudichum, however, are open to many and obvious objections.

Physical Properties.

Oxalic acid is a colourless, transparent, odourless solid, crystallizing in four-sided prisms, which are permanent in air, and not deliquescent. The oxalates generally are colourless, crystallizable salts.

Chemical Properties.

It has a very strong acid reaction. It is soluble in 9½ parts of water at 16° C., much more soluble in boiling water, freely soluble in alcohol, but insoluble in ether or chloroform. All the oxalates except the alkaline oxalates are insoluble in water.

Pure oxalic acid is dissipated entirely by a heat of 177° C., but *it does not char* when heated, and in this respect differs from all other vegetable acids. Sulphate of magnesia, it may be remarked here, leaves a fixed residue even when exposed to high temperatures, and may in this way be known from oxalic acid. All the oxalates are decomposed by heat, carbonic acid and carbonic oxide being given off, whilst a carbonate of the metal remains behind. If water be added to this residue, and afterwards a little acid, effervescence at once takes place.

Nitric and hydrochloric acids have no action on oxalic acid. Sulphuric acid decomposes it by the removal of water, carbonic acid and carbonic oxide being set free, but the acid is not charred, as happens with other organic acids. The oxalates acted upon by sulphuric acid undergo a similar decomposition.

Oxalic acid has no action upon any of the common animal principles except gelatin, which it dissolves, but neither the acid nor the gelatin are decomposed.

It forms insoluble oxalates with magnesia and chalk.

Symptoms, Dose, &c.

The symptoms of poisoning may set in immediately, whilst occasionally they are delayed for an hour or more. In one case a man is reported to have walked ten miles after swallowing 1 ounce.

The symptoms depend largely on the dose and on the degree of concentration of the solution.

If the solution be very concentrated, as it most often is, the symptoms consist in an immediate burning pain in the stomach, cramps and drawing up of the legs, the vomiting of dark and perhaps bloody coffee-ground matters, the patient complaining that the throat seems as if tightly bound round with a cord, and relief being sought by a constant hacking cough. If the patient lives, bloody purging sets in. The tongue will be found swollen, and the mouth sore, and usually white. A peculiar change in the voice has often been noticed, whilst an absolute loss of voice has also been recorded. Numbness and tingling of the legs, twitchings of the face, convulsions and delirium will all be more or less marked.

The circulation from the first gradually becomes very depressed, and the respiration slow and spasmodic, death occurring either from collapse, or from palsy of the heart, its power of contractility being entirely destroyed.

If the acid be taken in a state of greater dilution, death often results from the violence of the tetanic fits, suffocation being the prominent symptom. It would thus seem to act on the nervous system through the blood, in which, however, it has never yet been detected, although leeches have been said to fall off dead when applied to a patient who had taken a poisonous dose of the acid.

In a state of still greater dilution there may be no pain, spasms, or vomiting, but the patient will merely sleep to death, as if under the action of a narcotic poison.

Death may be almost instantaneous. Cases are recorded of death after three, ten, twenty, and twenty-five minutes, whilst sometimes life is prolonged for some days. A case is recorded by Beck, where some months passed before death occurred, which in the end resulted from secondary causes. One dram has proved fatal to a boy (aged 16) in twenty-one hours. Half an ounce may be considered a poisonous dose, although there are many cases recorded of recovery after double, and even more than double, that quantity.

It may be well to note that if there is any reason to suspect oxalic acid poisoning, the discovery of crystals of oxalate of lime in the urine, and which may be found for a week or more after the poison has been taken, will furnish an important element of diagnosis. In cases of poisoning by oxalic acid, where the acid is found on analysis, it is generally urged by the defence that it may have got into the system either through the food, or as a product of disease. Under these circumstances the quantity of the poison found, and the general history of the case, must form the basis of our evidence as to the cause of death. M. Henry states that he has found as much as 33 per cent. of oxalate of lime in rhubarb. We have never ourselves found anything like this quantity. In the Boston "Medical and Surgical Journal" (Jan. 27, 1870), Dr. White discusses at length the relationship between the symptoms and the morbid appearances of poisoning by oxalic acid, and those produced by disease. The reader is referred to this interesting memoir.

Treatment.

This must be expeditious, or it will be useless. The advice to "scrape the ceiling, and administer the scrapings, if you can get nothing else," is sound.

There are one or two definite points to be remembered in the treatment:—

(1) The stomach-pump must never be used.

(2) Warm water should never be given to induce vomiting, inasmuch as it aids absorption, by dissolving any of the acid that may remain undissolved.

(3) Alkaline carbonates are useless as antidotes, the salts formed being as poisonous as the original acid.

(4) The proper treatment consists, *first,* in the free administration of chalk or magnesia, held in suspension by *very small* quantities of fluid, such as milk, or other mucilaginous drink; and, *secondly,* after the acid is neutralized, the administration of emetics, supposing, as happens occasionally, that there is no vomiting.

The authors have reason to believe that opium in moderate doses greatly lessens the activity of this poison.

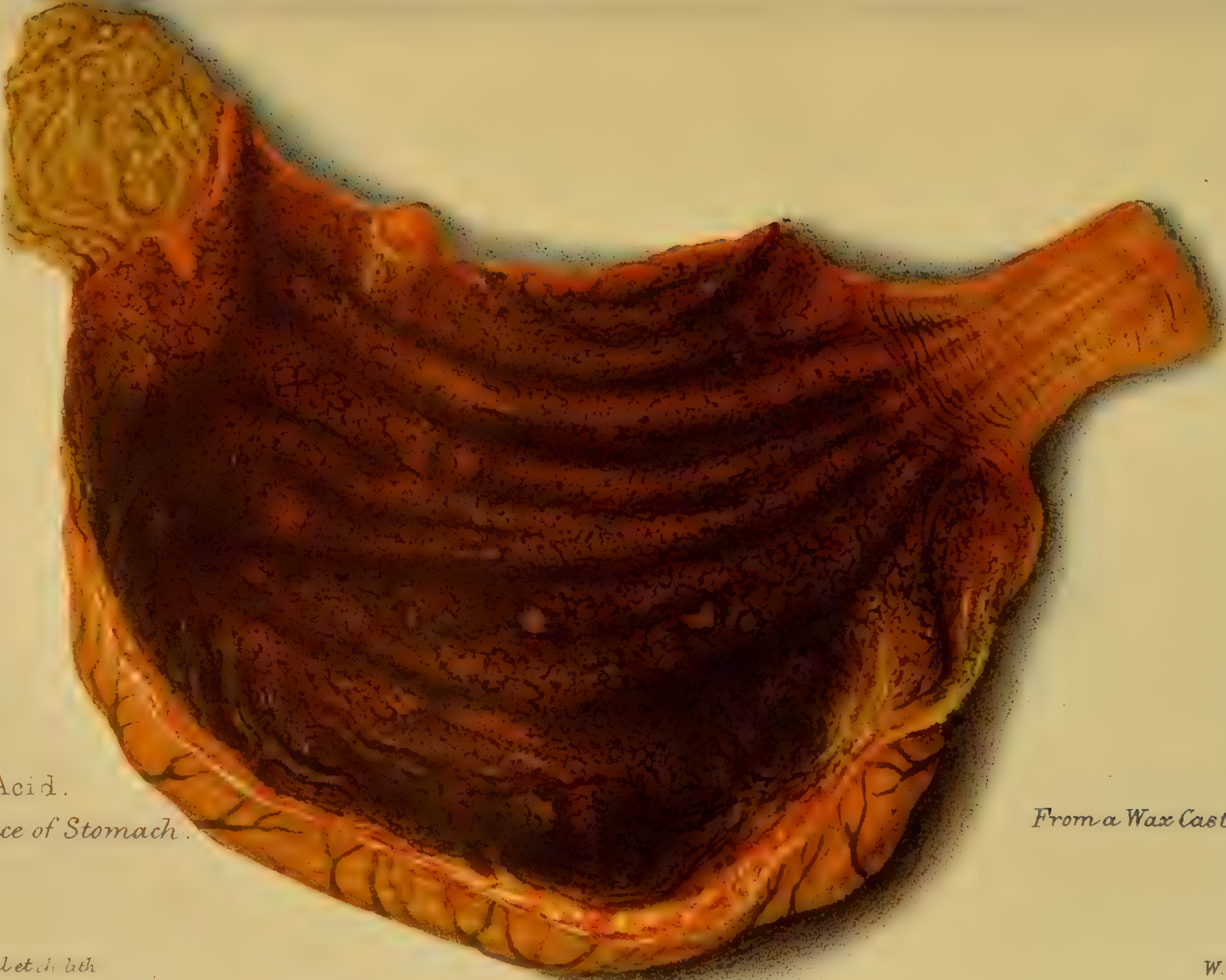
Post-Mortem Appearances.

The lining membrane of the mouth, throat, and gullet will usually be found white, shrivelled, and easy of removal. It may in the first instance be of a brown colour, from being coated with the contents of the stomach, discharged during vomiting. The epithelium in the gullet is often entirely destroyed, whilst the surface thus denuded appears brown, and raised in longitudinal folds. The stomach, which is frequently contracted, often contains an intensely acid, brown, gelatinous liquid; whilst the mucous membrane, if death be rapid, may appear soft and pale, but if death be at all delayed, it is then usually black in some parts, and in others intensely congested and in rugæ, with portions peeling off, and the coats underneath gangrenous. (Plate IV.)

As regards actual corrosion and perforation, the records of cases prove that such a state is rare. Still, as in that recorded by Dr. Letheby, as well as in other cases, softening and perforation of the stomach have been noticed.

The intestines will usually be found in a very congested and contracted condition, more or less throughout their whole length. The

Plate IV.



Oxalic Acid.

P.M. Appearance of Stomach.

From a Wax Cast by Dr. Letheby.

E. Burgess del et lith.

W. West & Co. imp.

state of the heart varies. It has been found at one time almost empty, and at another full of dark fluid blood.

Throughout the whole body, excepting in the stomach and the gullet, the blood is fluid. The lungs generally, and the brain occasionally, have been found congested. A few cases have occurred where all morbid appearances have been absent.

Tests.

(*a*). *Tests for Oxalic Acid.*

1. Acid taste and acid reaction to litmus paper (1 grain in a gallon of water gives a distinctly red tint to blue litmus).

(Note.—*Sulphate of magnesia* is bitter, and has a neutral reaction; *sulphate of zinc* a faintly acid reaction.)

2. It is entirely volatilized by heat, without being charred.

(Note.—Sulphates of magnesia and zinc both leave residues, even when subjected to very high temperatures.

3. It gives no precipitate with alkaline carbonates.

(Note.—The sulphates of magnesia and zinc give white precipitates.)

(*β*). *Tests for Oxalic Acid and the Alkaline Oxalates.*

1. *Nitrate of silver* gives a white amorphous precipitate of oxalate of silver ($Ag_2 C_2 O_4$), soluble in excess of oxalic acid, in ammonia, and in hot and cold nitric acid; insoluble in acetic acid, and not discoloured by boiling. If the precipitate be collected, dried, and heated on a piece of platinum foil, it explodes, carbonic acid being given off, and metallic silver only left behind; but this experiment is interfered with by the presence of organic matter, and further, if a little chloride be present, a residue of chloride will remain, after the explosion. (All white precipitates produced by nitrate of silver are soluble in nitric and in acetic acids, except chlorides and cyanides; but none explode when heated, except oxalates and fulminates.)

2. *Sulphate of lime* gives a white precipitate of oxalate of lime, which is soluble in nitric and in hydrochloric acids, but is insoluble in acetic acid. When this precipitate is ignited, carbonate of lime is formed, which dissolves in acetic acid with effervescence. It is necessary to add a somewhat large quantity of sulphate of lime solution to throw down all the oxalic acid, because of the insolubility of the calcium sulphate in water.

(Sulphate of lime gives a white precipitate, with neutral solutions of alkaline carbonates and phosphates, but these are soluble in acetic acid. It also gives a white precipitate with acid solutions of lead, baryta, and strontia; but these are insoluble in nitric, hydrochloric, or acetic acids.)

3. *Chloride of barium* gives a white precipitate of oxalate of baryta, which is soluble in nitric and in hydrochloric acids, as well as in a great excess of acetic acid.

(Chloride of barium also gives a white precipitate with sulphuric acid, and with the sulphates, but these are insoluble in nitric acid; also with neutral solutions of alkaline carbonates, but these are freely soluble in acetic acid.)

4. *Acetate of lead* gives a white precipitate of oxalate of lead, soluble in nitric, but insoluble in acetic acid.

(Acetate of lead also gives a white precipitate with sulphuric acid, and with sulphates and chlorides; but the precipitates thus formed are insoluble in nitric acid. It also gives a white precipitate with neutral solutions of carbonates and phosphates, and these are soluble in acetic acid.)

5. *Sulphate of copper* gives a light blue precipitate of oxalate of copper, insoluble in acetic acid, not very soluble in nitric acid, but very soluble in ammonia.

(Sulphate of copper also gives precipitates with neutral solutions of carbonates and phosphates; but these are very soluble both in nitric and hydrochloric acids.)

Toxicological Analysis.

In a toxicological investigation, supposing that the contents of the stomach are acid, they should be digested for some time with water, and filtered. Treat this filtrate with an excess of a solution of sub-acetate of lead, when a precipitate will be formed of oxalate of lead, mixed with organic matters in combination with oxide of lead. Collect this precipitate upon a filter-paper, and wash it thoroughly with water. Whilst the materials thus collected are moist, rub them up in a mortar with sufficient water to render the whole fluid. Pass washed sulphuretted hydrogen through the mixture to complete saturation, by which means the oxalate of lead will be decomposed. Filter, and test the clear solution (which is usually sufficiently pure for the purpose) by the several tests for oxalic acid. The use of sulphuretted hydrogen for decomposing the oxalate is infinitely to be preferred to boiling it with sulphuric acid, as is often recommended.

Such is the process to be adopted, if oxalic acid or the soluble oxalates are present; but if antidotes, such as lime or magnesia, have been administered, and the oxalic acid completely neutralized, the contents of the stomach must then be boiled for one or two hours with carbonate of potash. (Caustic potash must not be used, as possibly oxalic acid might be formed by the prolonged boiling of animal substances with the caustic alkali (Gay Lussac). After boiling, filter the mixture, and add to the filtrate excess of acetic acid; then precipitate the oxalic acid with acetate of lead, and proceed as before.

Always, if possible in poisoning cases, examine the urine, as the discovery of a large quantity of octahedral crystals of oxalate of lime at all times constitutes most important evidence. The urine is to be placed in a conical glass until the sediment collects; decant the clear solution, and examine the sediment under the microscope for oxalate crystals.

The oxalic acid is estimated quantitatively either as oxalate of lead—

100 grains of which = 42·5 of crystallized oxalic acid.

or, as oxalate of lime, which is to be ignited and weighed as a carbonate—

100 grains of which = 126 grains of crystallized oxalic acid.

Stains on Black Cloth, &c.

A solution of oxalic acid falling upon black cloth leaves a deep brown stain. It also rapidly bleaches writing ink, either on paper or in bulk. In the case of stains the fabric need only be treated with a little hot water, and the proper tests applied to the clear filtered solution ; whilst where it has been used to remove the colour of ink, an iron stain will probably be left upon the paper, which turns blue, if treated with a solution of ferrocyanide of potassium.

Acid Oxalate of Potash ($KH\,C_2\,O_4$, $H_2\,C_2\,O_4$, $2\,H_2\,O$).

(Binoxalate of Potash—Salts of Sorrel—Essential Salts of Lemons.)

This salt is largely used in straw bleaching, and by the public generally, for removing ink stains. As a poison it is as active as oxalic acid. It is insoluble in alcohol, and not very soluble in water. It has been mistaken for the acid tartrate with a fatal result. The acid tartrate does not bleach ink, and is not precipitated by a lime or silver salt. It crystallizes in rhombic prisms, and behaves similarly to oxalic acid in all its reactions, except in the circumstance that it is not completely volatile when heat is applied, but leaves a white alkaline ash, consisting of carbonate of potash. It has also been taken by mistake for Epsom salts. The symptoms produced by it are similar to those resulting from the administration of oxalic acid. Death is usually rapid, two cases of eight and ten minutes' interval being respectively recorded, and a third case of an hour and a half. Half an ounce has proved fatal, but recovery is recorded after 1 ounce.

Cases of Poisoning with Oxalic Acid.

1. "Lancet," July 11, 1846, p. 39 (Dr. Brush). Male : æt. 60. ℥j in solution.		
Symptoms.—(Emetics given directly); pain, thirst, and drowsiness, for 6 hours ; recovery.	*Result.*—Recovery.	
2. "Lancet," Oct. 19, 1844, p. 103 (Dr. Letheby). Female : æt. 22. Oxalic acid.		
Symptoms.—Found dead the next morning.	*Result.*—Death.	*Post-mortem.*—Stomach much blanched ; very softened and disorganised; and at the cardiac end appeared positively pulpy, with numerous perforations.
3. "Lancet," Dec. 1, 1851, p. 521 (Dr. Barker). Male : æt. 16. ʒj taken as solid.		
Symptoms.—Symptoms set in after 1 hour; insensibility; lower jaw spasmodically closed; became, after a time, partially sensible, but very drowsy ; bloody vomiting.	*Result.*—Death in 21 hours.	*Post-mortem.* — Tongue dotted with white specks ; œsophagus not inflamed ; stomach gangrenous.

4.

"Lancet," Sep. 3, 1864, p. 265 (Dr. Ellis). Female: æt. 50. ℥j.

Symptoms.—Symptoms came on within half an hour; violent pain; ineffectual attempts to vomit; treatment adopted within half an hour after taking the poison.	*Result.*—Recovery.	

5.

"Lancet," Sep. 28, 1867, p. 394 (Dr. Beale). Female: æt. 34. ℥ss.

Symptoms.—Immediate pain and giddiness. Sickness in 15 minutes; purging in 1 hour; thirst intense; blood was passed both by mouth and by stool for 5 days; got better; on the 7th day, however, the pain and purging returned, and she died from exhaustion.	*Result.*—Death on 7th day.	*Post-mortem.*—Tongue and mouth *unaltered* in appearance; mucous membrane of œsophagus stripped off; a slough the size of a crown piece found at the lower part of the greater curvature of the stomach; intestines congested; lungs inflamed.

6.

"Medical Times and Gazette," Oct. 8, 1864, p. 386 (Dr. Woodman). Female. ℥ss.

Symptoms.—In 1 hour the tongue was found whitened as if boiled; pain in stomach, and collapse; chalk mixture given; vomiting of blood; Large quantity of oxalate of lime and blood found in the urine for a week.	*Result.*—Recovery in 10 days.	

7.

"Lancet," Dec. 15, 1860, p. 592 (Mr. Ikin). Male: æt. 26. ℥j taken on an empty stomach.

Symptoms. — Immediate vomiting; purging.	*Result.*—Death in 25 minutes.	*Post-mortem.*—Brain, heart, lungs, and kidneys healthy; liver congested; mucous membrane of stomach very congested and corrugated.

8.

"Lancet," Nov. 24, 1860, p. 509 (Dr. Page). Male: æt. 31. ℥j.

Symptoms.—Symptoms severe. After treatment he seemed to get much better, but the vomiting and pain remained persistent.	*Result.*—Death on 5th day.	*Post-mortem.*—Stomach congested, but the mucous membrane was entire; it contained bloody fluid; fatty degeneration of the heart; bloody fluid found in pericardium, and in each pleura; liver large and fatty; spleen healthy.

9.

"Medical Times and Gazette," April 25, 1868, p. 456 (Dr. Herapath). ʒvi.

Symptoms.—Vomited almost all the poison.	*Result.*—Death in 10 minutes.	

10.

"Medical Times and Gazette," Sep. 14, 1850, p. 293 (Dr. T. W. Bradley). Male: adult. ʒij. Patient was a hard drinker.

Symptoms.—Symptoms severe; burning pain; thirst; clammy perspirations; numbness and tingling in extremities. In 9 hours an alteration of the voice set in, and this lasted for a month.	*Result.*—Recovery.	

11.

"British Medical Journal," May 20, 1871, p. 532 (Dr. Goodfellow). Male: æt. 54. A teaspoonful in tea.

Symptoms. — Pain and difficulty of swallowing; slight collapse; pupils natural.	*Result.*—Recovery.	

12.

"Lancet," March 22, 1851, p. 329 (Mr. Bourne). Female: adult. ʒiij in 3 ozs. of water.

Symptoms.—(Stomach pump used in a quarter of an hour); convulsions; tetanic spasms; the spasmodic twitchings continued for a month.	*Result.*—Recovery in 3 months.	

13.

"Boston Medical and Surgical Journal," vol. xxx., p. 17 (Dr. Jackson). Male: æt. 30. ℥j.

Symptoms.—Vomiting set in immediately; collapse after 12 hours; vomiting with great distress, continued for 6 days; on the 6th day his mind began to wander, and petechious spots appeared on the body; death.	*Result.*—Death on the 10th day.	*Post-mortem.* — Stomach thickened, soft, bright red, and congested; heart empty.

14.

Wharton and Stillé's "Medical Jurisprudence," p. 496. Female. About 1½ oz. in mistake for Epsom salts.

Symptoms. — Vomiting in twenty minutes; free purging.	*Result.* — Recovery.	

15.

"Medical Times," Oct. 9, 1841, p. 15. Female: æt. 17. ℥ss in water.

Symptoms.—Immediate burning pain and bloody vomiting in 10 minutes.	*Result.* — Recovery in 24 hours.	

16.

"Medical Times," Oct. 9, 1841, p. 15. Male: æt. 40. ℥j in warm brandy and water.

Symptoms. — Pain and vomiting of thick slimy mucus.	*Result.*—Death on the 5th day.	*Post-mortem.*—Œsophagus much contracted and inflamed; stomach slightly inflamed.

17.

Taylor's "Medical Jurisprudence," vol. i., p. 224 (Mr. Welch). Female: 28. ʒiij.

	Result.—Death in 1 hour.	*Post-mortem.*—Lungs extensively congested; heart full of dark blood; stomach reddened; all other organs, except the brain, healthy.

18.

"Lancet," Aug. 23, 1845 (Dr. Ogilvy, Coventry). Female: 43. ℥j to ℥ij.

Symptoms. — Vomiting, collapse, and death in 3 minutes.	*Result.*—Death in 3 minutes.	*Post-mortem.*—Heart full of black uncoagulated blood; the stomach was rotten, and contained some dark gelatinous fluid; the œsophagus appeared as if boiled, the mucous membrane pealing off.

19.

"Lancet," Sep. 13, 1845 (Mr. M. K. O'Shea). Male: adult. ℥j.

Symptoms.—After taking it the man travelled 10 miles; after 14 hours there was great pain and prostration, and vomiting of dark bloody matter; recovery.	*Result.* — Recovery.	

20.

"Lancet," Oct. 18, 1845 (Dr. Iliff). Female: adult. Saturated solution.

Symptoms.—No convulsions.	*Result.*—Death instantaneous.	

21.

"Lancet," Aug. 17, 1839, p. 748 (Mr. Anderson). Female: æt. 22. A quantity.

Symptoms.—Immediate vomiting, and death in 20 minutes.	*Result.*—Death in 20 minutes.	*Post-mortem.*—Heart healthy; distinct rugæ of mucous membrane of gullet and stomach, but without inflammation. The intestines were contracted, but not reddened.

22.

"Lancet," Sep. 28, 1839, p. 29. Female: æt. 30. (?).

Symptoms.—No symptoms described.		*Post-mortem.*—Mucous membrane of stomach very inflamed and perforated.

23.

"Lancet," April 30, 1842, p. 145 (Dr. R. B. Todd). Female. A pennyworth (?).

Symptoms. — Immediate and severe abdominal pains; vomiting and cramps; recovered without a bad symptom.	*Result.* — Recovery.	

24.

"Lancet," May 1, 1841, p. 187 (Dr. R. H. Semple). Female: æt. 23. ʒij.

Symptoms.—Immediate vomiting; intense pain in 14 hours.	*Result.* — Recovery.	

25.

"Lancet," July 13, 1872, p. 41 (Dr. Tidy). Two sailors. Each took a draught containing oxalic acid instead of Epsom salts.

Symptoms.—(1) Complete coma and death.	*Result.*—Death in 5 hours.	*Post-mortem.*—Oxalic acid found in stomach.
Symptoms.—(2) Vomiting and recovery.	*Result.* — Recovery.	

26.

"Lancet," Nov. 2, 1850, p. 502 (Mr. Allison). Male: æt. 22. ℥j in 1 pint of water.

Symptoms. — Vomiting; (chalk and magnesia given, and use of stomach pump attempted).	*Result.* — Recovery.	

For further Cases of Poisoning by Oxalic Acid, see—

"British Medical Journal," Jan. 8, 1870, p. 40. (Death.)
"Medical Times," April 18, 1846, p. 45. (Three cases.)
"Medical Gazette," vol. xxxvii., p. 792. (Vomiting of a colourless liquid.)
"Provincial Journal," June 25, 1851.
Taylor's "Medical Jurisprudence," vol. i., p. 225. (Perforation of stomach.)

(II.) BINOXALATE OF POTASH.

27.

"Medical Times and Gazette," Oct. 15, 1859, p. 378 (Dr. Webb). Male: æt. 40. A quarter of a teaspoonful of binoxalate of potash.

Symptoms.—Great thirst and burning in throat, but no well marked abdominal pain; vomiting in 2 hours; loss of power in limbs; lumbar pains and cramps set in later on in the case.	*Result.*—Recovery.	

28. "Medical Gazette," vol. xxvii., p. 480. Female: æt. 20. ℥j.		
Symptoms.—In an hour and a half was found in a state of exhaustion and great depression, with a cold skin, a clammy pulse and shivering; she had previously vomited; conjunctivæ much injected and pupils dilated; dimness of vision.	*Result.*—Recovery.	
29. "Medical Times and Gazette," Feb. 12, 1859. About ℥ss (= 225 grains).		
(Bicarbonate of soda was given as an antidote!)	*Result.*—Recovery.	
30. Taylor's "Medical Jurisprudence," vol. i., p. 229; "Journ. de Chim. Méd.," 1842, p. 211. Female: adult. ℥ss.		
Symptoms.—Pain and convulsions.	*Result.*—Death in 8 minutes.	
31. "Annales de Hygiène," 1850, p. 162 (M. Chevallier).		
	Result.—Death in 10 minutes.	
32. "Pharmaceutical Journal," March, 1872, p. 760. A quantity taken by mistake for Epsom salts.		
	Result.—Death in 1½ hours.	
33. "Edinburgh Monthly Journal," July, 1862, p. 92. Apparently the result of chronic poisoning.		
	Result.—Death.	
34. "Annales de Hygiène," 1842, vol. xxvii., p. 422. A teaspoonful taken for three successive mornings.		
Symptoms.—Severe vomiting.	*Result.*—Death in 1 hour after the third dose.	

PYROGALLIC ACID ($C_6 H_6 O_3$).

This acid is found in the shops in the form of light feathery crystals, and is largely used by photographers. It strikes a red colour with a neutral ferric salt, and a blue colour with a ferrous salt.

No case of poisoning has occurred by it in the human subject; but 2 grains have been found to kill a dog in sixty hours (Personne). In experiments on animals, fatty degeneration of the muscular fibres of the heart has been noticed as a general and prominent post-mortem appearance. Urine containing this acid blackens almost instantly when rendered alkaline, from absorbing oxygen.

Turpentine is said to be the best antidote.

TARTARIC ACID ($H_2 C_4 H_4 O_6 = 150$).

Tartaric acid is the acid of the juice of grapes, and of other fruits. When pure, it is perfectly colourless, and crystallizes in oblique rhombic prisms. It is soluble in five or six times its weight of cold water, but is not nearly so soluble in alcohol.

When heated it fuses and burns with a light red flame, a considerable charcoal residue remaining, and a peculiar odour of burnt sugar evolved.

It gives no precipitate, like oxalic acid, with nitrate of silver, but a white precipitate (cream of tartar) is produced by potash salts, which in dilute solutions is largely increased by active stirring.

Tartaric acid is an irritant poison. Fifteen grains will kill a dog when injected into the veins (Pommer). One ounce has proved fatal to an adult in nine days.

The treatment must consist in the exhibition of alkalies, and in producing free vomiting.

Cases of Poisoning by Tartaric Acid.

1. Taylor's "Medical Jurisprudence," vol. i., p. 230, Reg. *v.* Watkins, Central Criminal Court, Jan. 1845; also "Lancet," 1845, vol. i., p. 18 (Mr. W. Seth Gill). Male: æt. 24. ℥j taken by mistake for aperient salts.		
Symptoms. — Exclaimed immediately that he was poisoned, and felt as if on fire; (alkalies were administered;) vomiting set in and continued for 9 days, when he died.	*Result.*—Death in 9 days.	*Post-mortem.*—Alimentary canal highly inflamed.
2. "Annales de Hygiène," 1851, vol. ii., p. 432 (M. Devergie).		

CHAPTER XV.

Alcohol—Symptoms, &c.—Tests—Toxicological analysis—List of cases—*Amylic alcohol*—*Methylic alcohol*—*Nitrite of amyl*—*Amylene*—*Benzol*—*Nitro-benzol*—Symptoms—Treatment, &c.—Experiments on animals—Tests—Toxicological analysis—List of cases—*Aniline*—Properties—Symptoms, &c.—Experiments on Animals—Tests—List of cases—*Carbolic Acid*—Properties—Symptoms, &c.—Action on Animals—Tests—List of cases—*Bisulphide of carbon*—*Chloral and Bromal*—Symptoms, &c.—List of cases—*Chloroform*—Tests of purity—Symptoms, &c.—Toxicological analysis—List of cases—*Oil of Dippel*—*Ether*—Nitric ether—Symptoms—*Kreasote*—*Bichloride of methylene*—*Coal naphtha*—*Nitro-glycerine*—*Turpentine.*

ALCOHOL = $C_2H\ O$.

[*Hydrate of Ethyl* ($C_2\ H_5$).]

(Sp. gr. at 15·5° C. = 0·7938—boiling point 78·4° C.)

Absolute alcohol is prepared by distilling pure alcohol in a retort with its own weight of quick lime, with which it has been allowed to remain in contact for some days, the distillation being conducted over dry potassic carbonate. *Proof spirit* (sp. gr. = 0·920), is defined by law as a mixture of water with 49·24 per cent. of alcohol. Every 0·5 per cent. of alcohol above this corresponds to one degree over proof. *Methylated spirit* consists of spirit mixed with 10 per cent. of wood naphtha or methylic alcohol ($CH_4\ O$), a liquid formed by the destructive distillation of wood. The mixture has the characteristic smell of the methyl alcohol. In most of our spirits the absolute alcohol varies from 51 to 54 per cent.—in our strong wines from 12 to 17—in our light wines from 7 to 9—and in strong malt liquors from 5 to 6.

Alcohol is a volatile colourless liquid having a pleasant odour, and a pungent taste. It burns with a blue colourless flame, the products of its combustion being water and carbonic acid. If its vapour be mixed with an insufficient supply of air for complete combustion, and passed over hot platinum, a partial combustion results, an exceedingly irritating pungent compound being formed. The vapour is entirely decomposed by passing it through a red hot tube, carbonic oxide, olefiant gas, marsh gas, hydrogen, and other hydrocarbons resulting. Alcohol mixes with water in all proportions. No mineral salts that are insoluble in water are soluble in alcohol. Very few efflorescent salts are soluble, and very few deliquescent salts are insoluble in it. It dissolves camphor freely, and to a certain extent oxygen, hydrogen, and nitrogen. It also dissolves the fixed caustic alkalies, the mixture becoming oxidized when exposed to the air, and the colour changing by the formation of a so-called resin of aldehyd (Williamson). By dissolving potassium and sodium in it, a potassic or sodic ethylate is formed, hydrogen being disengaged, and a considerable rise in the temperature of the mixture produced.

Alcohol, heated with sulphuric acid in the proportion of 1 of alcohol to 2 of acid, produces ether and water; but, if the mixture be made in the proportion of 4 of the acid to 1 of alcohol, then olefiant gas and water are the principal products.

If alcohol be heated in a tube with sulphuric acid, together with water and oxide of manganese, it will be acted upon by the nascent oxygen set free by the action of the acid on the manganese oxide and aldehyd ($C_2\,H_4\,O$) be formed ;—

$$2\,\underbrace{C\ H_6\,O}_{\text{Alcohol.}} + O_2 = 2\,\underbrace{C_2\,H_4\,O}_{\text{Aldehyd.}} + 2\,H_2\,O.$$

This aldehyd rapidly oxidizes and becomes acetic acid ;—

$$2\,\underbrace{C_2\,H_4\,O}_{\text{Aldehyd.}} + O_2 = 2\,\underbrace{C_2\,H_4\,O_2}_{\text{Acetic Acid.}}.$$

Alcohol acts as a true poison, whether the vapour be respired, or the liquid be swallowed, or injected into the cavity of the chest or into the cellular tissue. (*See* On Alcohol Poisoning, "Medical Times," Feb. 3, 1849, pp. 295 and 327, and also March 17, 1849, p. 395.) A very striking case is on record ("Lancet," April 26, 1873, p. 601), where an infant suffered from convulsions and other symptoms caused by the abuse of alcohol in the nurse. The milk, therefore, may act as a carrier of the poison.

Symptoms, Dose, &c.

These usually commence, in from a few minutes to one hour, according to the strength of the spirit, and the quantity taken. The symptoms usually run some such course as this. The patient complains of headache and weakness, a feeling of sleepiness, but an inability to sleep. He is constantly moving about, but walks unsteadily—he is constantly talking, but his talk is a disjointed unintelligible jabber, and he sees everything double. The conjunctivæ are usually congested, the skin bathed in a cold perspiration, the lips blue, the face flushed, the breathing stertorous. The pupils are generally dilated, but this is by no means constant. In twenty-six cases where the state of the pupil was noted by Dr. Ogston, it was contracted in six, and dilated in twenty. In acute poisoning Mr. Bedingfield thinks that the prognosis is far more favourable if the pupil is contracted, however intense may be the coma. Insensibility, or a profound coma, sooner or later, comes on, from which the patient may never rally. Preceding the stage of intense coma, convulsions are not uncommon. If the insensibility passes off, as a rule, the patient gets well, although, even under these circumstances, the prognosis must be guarded, as several cases are on record where a brief period of seemingly perfect health, supervened between death and the active symptoms induced by, or traceable to, the poison. A free and active attack of vomiting, succeeded by a sound sleep, especially if accompanied by a profuse perspiration, are most favourable signs, and usually precede complete recovery. The symptoms, however, are liable to some variation, as occasionally they have all the characteristics of a true irritant poison. Nor must we overlook in cases where death occurs from what appears to be alcoholic poisoning, the possibility that it may be due to an accident whilst the patient was in a state of intoxication. And further, there is often a singular similarity, and some difficulty of diagnosis, between the symptoms induced by alcohol and those arising from opium or concussion of the brain. The symptoms of alcohol poisoning will vary somewhat if the patient has been an habitual drunkard; although, even in such cases, active symptoms may be induced by an excessive debauch. The trembling hands—the busy delirium—the hallucinations of sight and hearing—the suspicions manifested about everything and everybody—the moist furred tremulous tongue—the clammy skin—and lastly, the strong smell of alcohol in the breath, leave little difficulty, as a rule, with proper care, in arriving at a correct diagnosis.

The frequent repetition of small quantities of alcohol, accumulating, as it undoubtedly does, in the liver and in the nerve centres, notwithstanding its elimination by excretory organs, such as the lungs and kidneys, present us with a class of cases of chronic poisoning with which, unfortunately, we are now-a-days too familiar. This is, moreover, a subject demanding considerable attention from the medical jurist, inasmuch as the plea that a dipsomaniac is not to be regarded as a responsible being, is constantly urged on behalf of a prisoner by counsel who have no other grounds of defence. This we shall discuss elsewhere. The train of symptoms, the result of chronic alcoholism, such as cirrhosis, induration of portions of the nervous centres, congestion of the respiratory organs, thickening of the walls of the stomach, &c, are undoubtedly to be regarded as the results of certain morbid changes produced by the poison. A question of some importance may arise, how far many of the symptoms found in delirium tremens are due to admixture of fusel oil (amylic alcohol) with the alcohol (ethylic). We have ourselves noticed, in experimenting with alcohol, the constancy of convulsions when amylic alcohol was administered, and their rarity under the influence of pure alcohol. But this is a subject needing further and careful enquiry.

In acute poisoning death may be very rapid and almost instantaneous either from shock or from apoplexy, a state not unlikely to be induced under the action of alcohol in a person predisposed to it. Cases of death after two, six, and sixty-seven hours are also recorded. As regards *dose*, a child (æt. three) died from drinking a mixture of a quartern of rum and 2 ozs. of gin. Half a pint of gin has proved fatal to an adult. On the other hand, recovery is recorded after a quart of gin and a quart of whisky in adults, and after 3 ozs. of rum in a child five years old.

Treatment.

The one great indication in acute poisoning by alcohol is to get rid of the poison. The stomach pump is better than any emetic. The use of the catheter is indicated if the bladder is distended. Often, in this way, consciousness may be immediately restored. The cold douche, and injecting water into the ears (Dr. Ogston), are useful. A free supply of fresh air is essential. If much cerebral congestion is present, venæsection may be tried, although Dr. Ogston does not consider it, as a rule, necessary. If the patient be asphyxiated, galvanism may be used with advantage. If the stupor be intense, ammonia should be given. If the patient be thirsty, there is nothing better to give for drink than strong coffee.

Cases of chronic poisoning must be treated on general principles, the several symptoms being met as they arise.

Post-Mortem Appearances.

In a case of acute poisoning, the stomach will appear either completely or in part of a deep cherry red colour, the congestion extending usually both into the gullet and into the intestines. The smell of alcohol will be perceived if death be rapid, and the quantity taken large. The mucous membrane of the stomach is frequently thickened and shrivelled. Sometimes the brain appears perfectly healthy, except that there may be serous effusion under the arachnoid and into the ventricles. At other times it will be observed to be considerably congested, and if apoplexy has been the cause of death, extravasated blood will be found. The lungs are invariably congested, the blood in the heart and large vessels being fluid and of a dark colour. Dr. Voltolini ("Medical Times and Gazette," May 1, 1858, p. 457), states, as the result of a large experience, that he has uniformly found in alcohol poisoning the pulmonary and aortic valves of the heart of a peculiar cinnabar-red colour, which discolouration cannot be removed by wiping.

The post-mortem appearances in chronic cases of alcohol poisoning are "the gin-drinker's liver," as well as certain morbid changes in the nervous centres, the respiratory organs, the stomach, the heart and the kidneys.

Tests.

1. (*a*) Taste ; (*b*) Smell ; (*c*) Volatility.

2. It burns with a lambent blue flame, which does not blacken a piece of white porcelain held in it, and does not leave any residue when the combustion is at at end.

3. If, to a solution containing alcohol, a few drops of a solution of bichromate of potash and sulphuric acid be added, and heat applied, an emerald green coloured solution is produced, and a peculiar fruity odour evolved (Aldehyd, $C_2 H_4 O$). One of bichromate to 300 of acid is a good strength.

4. Heat the alcohol with oxide of manganese and sulphuric acid in a retort, and distil into a well-cooled receiver, when aldehyd will be produced ($C_2 H_4 O$). Set the distillate aside for some days, when it will become acid to litmus from the production of acetic acid ($C_2 H_4 O_2$), the aldehyd odour having disappeared. Neutralize the acid solution with carbonate of soda, and boil so as to get rid of the alcohol. On adding to the liquid a little sulphuric acid, the vinegar odour will be at once perceived.

5. If it be a weak solution of alcohol we are testing, saturate the mixture with potassic carbonate, when the alcohol will float on the surface, the salt effecting the separation, owing to its perfect solubility in water, but its perfect insolubility in alcohol.

Toxicological Analysis.

In a toxicological investigation, the contents of the stomach, the brain, the blood and the secretions must be specially examined. Note first whether alcohol can be detected in these by the smell.

Neutralize whatever you may be examining, if acid, with carbonate of potash; and submit the whole to distillation, using a Liebig's condenser to effect perfect condensation. The distillate is then to be mixed with carbonate of potash in great excess, and the supernatent liquid either syphoned off or drawn off with a pipette. This process should be repeated several times, and, when the alcohol is sufficiently concentrated, the solution is to be tested with bichromate of potash and sulphuric acid, in the manner already described.

Dr. Taylor recommends conducting the vapour from the flask in which the materials are being distilled, into a glass tube containing a few fibres of asbestos moistened with a mixture of a saturated solution of bichromate of potash and sulphuric acid, which the merest trace of alcohol vapour will be sufficient to turn green.

If some time has elapsed between death and the exhibition of the poison, no trace of alcohol may be discovered.

Lastly, it must be remembered that alcohol may be only the vehicle in which some other and more active poison may have been administered; therefore, even supposing the presence of the spirit to be clearly proved, the necessity still remains for the further examination of the viscera and of the contents of the stomach for other poisons.

Cases of Poisoning with Alcohol.

1.

"Lancet." May 4, 1839, p. 231 (Dr. Chowne). Male: æt. 7. Half a pint of gin.

Symptoms.—Complete insensibility in half an hour; pupils contracted; no delirium; injection of conjunctivæ; convulsions; death.	*Result.*—Death in 67½ hours.	*Post-mortem.*—No particular post-mortem appearances, except that all parts seemed dry; no odour of the spirit observable.

2.

"Lancet," May 18, 1839, p. 314, from "Journal de Chemie," March, 1839. Male: æt. 4. A quantity of mixed spirit (about ℥ij).

Symptoms.—Immediate and profound coma; pupils largely dilated. The coma began to disappear after 12 hours, but it was some time before he was well.	*Result.*—Recovery.	

3.

"Lancet," Oct. 26, 1839, p. 166 (Dr. G. Bird). Male: adult. Eight ozs. of alcohol 50° above proof.

Symptoms. — Instantly dropped down senseless; skin cold; lips blue; almost pulseless. In 11 hours again became sensible; went to work the following day, but felt heavy for sleep, and mistook objects. After 3 weeks further bad symptoms set in, his pupils were dilated, and he was slow in answering questions. The motions were pitch-like in appearance.	*Result.*—Recovery.	

4.

"Lancet," Oct. 26, 1839, p. 166 (Mr. Gregory Smith). Male: æt. 16. Two-thirds of a pint of gin at a draught.

Symptoms. — Soon became insensible; dilated pupils; pulseless. After 13 hours recovered his senses, but never had good health afterwards.	*Result.*—Recovery.	

5.

"Lancet," May 9, 1868, p. 589. Two male adults. Drank large doses of rum.

Symptoms.—Both became insensible; faces blue; pupils dilated and insensible; stertorous breathing. One vomited, the other did not. (Stomach-pump used.) The man that vomited recovered in 2 days, the other man died in 6 hours.	*Result.*—Recovery. Death in 6 hours.	

6.

"Lancet," Jan. 27, 1855, p. 89 (Mr. Hawkes). Male: æt. 22. Lay under a puncheon of rum, and let it run down his throat.

Symptoms.—Collapse; pupils dilated; intense perspiration.	*Result.*—Recovery.	

7.

"Medical Times and Gazette," Sep. 8, 1860, p. 236 (Dr. Rose). Male: æt. 3. A quartern of rum, and about ℥ij of gin.

Symptoms.—Insensibility set in in 10 minutes; no stertor; pupils immensely contracted; face flushed; (emetics were given;) after a short time the pupils became dilated; convulsions set in and death.	*Result.*—Death in 2 hours.	*Post-mortem.*—Post-mortem in 18 hours. Mucous membrane of stomach injected; lungs congested; left side of heart full; blood fluid; brain and membranes intensely congested.

8.

"Lancet," Sep. 8, 1860, p. 238 (Dr. Parkes). Male: æt. 5. Half a quartern of rum = ℥iij.

Symptoms.—Coma in 1½ hour; face flushed; perspirations; (stomach-pump used after 5 hours).	*Result.*—Recovery.	

9.

"British Medical Journal," Feb. 4, 1871, p. 122 (Dr. Lyons). Male: æt. 19. A quart of whisky.

Symptoms.—Coma for 24 hours; afterwards pulmonary lesion set in.	*Result.*—Recovery.	

10.

"British Medical Journal," Feb. 11, 1871, p. 144 (Dr. Elliston). Male: æt. 35.

Symptoms.—Became quite insensible; pupils contracted (galvanism used).	*Result.*—Recovery.	

11.

"Lancet," March 29, 1862 (Dr. Wiltshire). Male: æt. 65. One pint and a half of mixed gin and brandy.

Symptoms.—Coma in 15 minutes; pupils dilated and insensible to light; breathing oppressed.	*Result.*—Recovery.	

12.

"Lancet," March 29, 1862 (Dr. Wiltshire). Male: æt. 26. A quart of gin drank during 2½ hours.

Symptoms.—Insensibility; pulselessness; pupils contracted; breathing stertorous; foaming at mouth.	*Result.*—Recovery.	

AMYLIC ALCOHOL ($C_5H_{12}O$).

(Fusel oil—Potatoe spirit—Oil of grain.)

(Sp. gr. 0·817. Boils at 132·0° C.)

Amylic alcohol is much less volatile than ordinary alcohol; and hence, in the distillation of brandy from potatoes or barley or rye, it does not pass over—at any rate in any considerable quantity—until towards the end of the distillation.

It is a thin oily fluid, having an exceedingly unpleasant odour and a burning taste. It inflames with difficulty, and then burns with a blue flame. It is not acted upon by air under ordinary circumstances, but is oxidized to *valeric acid* ($C_5 H_{10} O_2$) when warmed and dropped on platinum black. It is insoluble to a great extent in water, on which it floats. It is not very soluble in chloroform, but is freely so in alcohol and in ether. Heated with a moderate quantity of sulphuric acid, it does not produce ether like vinic alcohol, nor is olefiant gas produced when the sulphuric acid is added in greater quantity. It decomposes chromic acid similarly to alcohol, ether, and wood spirit.

Its action, as a poison, is probably most energetic when the vapour is breathed; hence arises the paramount necessity of good ventilation in places where spirit is being distilled. Its action on the respiratory organs is marked by an extreme irritation, by dyspeptic symptoms, and by giddiness. Given internally, Dr. Furst of Berlin found that 2 drams would kill a rabbit in two hours, 3 drams in one hour, and 1 oz. in four minutes. In a case of poisoning, one would expect to detect its smell without difficulty in the breath.

Tests.

In organic mixtures fusel oil may easily be separated by ether, in which it is soluble. It may then be tested—

1. By its smell. This is best noticed by rubbing a little upon the hands, and holding them over the mouth and nostrils.
2. By mixing one part of fusel oil with two parts of acetate of potash and with one of sulphuric acid, when the odour of the essence of the jargonelle pear will be evolved (acetate of oxide of amyl).
3. It may also be tested by mixing it with bichromate of potash and sulphuric acid, when the green oxide of chromium will be produced.

METHYLIC ALCOHOL ($C H_4O$).

(Wood Spirit—Wood Naphtha—Naphtha—Pyroxylic Spirit.)

(Sp. gr. 0·82. Boils at 66·0° C.)

Methylic alcohol is produced, along with other bodies, by the destructive distillation of wood, but never as yet by any process of fermentation. When wood is distilled, a quantity of tar and water (containing acetic acid and wood spirits) pass over. This water, after being neutralized with lime, is again distilled, the crude naphtha, together with a little water, coming over at the commencement of the operation. The distillate is then partially dried by distillation over quick lime. The body thus obtained is that usually found in commerce. To prepare from this pure methylic alcohol, it must be mixed with a strong solution of caustic soda, and, after standing for some time, re-distilled, when acetate of soda will be left behind in the retort. The distillate should be then again distilled with 3 or 4 per cent. of sulphuric acid, volatile bases (such as ammonia) and certain impurities of the wood spirit being in this manner retained.

The crude "naphtha" is a yellowish liquid having an unpleasant smell, and a burning taste. Pure methylic alcohol is perfectly colourless. Spirits of wine mixed with 10 per cent. of wood spirit constitutes ordinary "methylated spirits," which possesses, even at that dilution, the characteristic smell of the methylic alcohol.

Wood naphtha differs from coal naphtha in mixing with water freely. It is soluble in alcohol and in ether in all proportions. Some turbidity results when ordinary wood-spirit is thus diluted, from the precipitation of liquid hydrocarbons. The vapour is inflammable, burning with a pale flame. It dissolves potassium and sodium, hydrogen being at the same time set free. The properties of methylic alcohol closely resemble vinic alcohol. Hydrogen acids (such as H Cl), form with it water and methyl compounds, the radical methyl ($C\ H_3$), being substituted for the hydrogen atom. If heated with four times its weight of sulphuric acid, methylic ether (C_2H_6O) and water, together with other products, are formed.

Wood naphtha dissolves most fatty and resinoid bodies readily, and for this reason is largely used in the arts, as well as in the manufacture of varnishes.

Poisoning by methylic alcohol is rare. Dr. Taylor relates a fatal case that occurred in 1864. We have, however, seen several cases where severe symptoms have been produced on workmen, in manufactories where it was largely used, from the contamination of the atmosphere of the workshop with the vapour. The symptoms are those of a narcotic poison. The post-mortem appearances noticed in the case related by Dr. Taylor, were an inflamed stomach and congested lungs.

The remarks we have made on the treatment of poisoning by alcohol (page 499), will equally apply here.

NITRITE OF AMYL ($C_5H_{11}NO_2$).

Nitrite of Amyl has been experimented upon by Richardson ("British Medical Journal," September 26, 1863, p. 356), and by Amez-Droz ("Archives de Physiologie," No. 5, 1873, p. 467). Great uneasiness, increase in the rate of the heart's contractions, much flushing of the face from dilatation of the bloodvessels, and irregular respiration with paralysis, were produced by small doses; whilst convulsions, the involuntary passing of the urine and fæces, coma, and death were produced when the doses were large. By injecting doses of 7 to 10 grains under the skin of rabbits, Hoffmann found that the quantity of urine voided during the twenty-four hours, was double what was normal, and contained from 1 to 2·5 per cent. of sugar. This diabetic condition disappeared in from twelve to thirty hours.

AMYLENE (C_5H_{10}).

(Boils at 35·0° C.)

Amylene is a colourless liquid, having an unpleasant odour. The vapour burns with a bright smoky flame.

It was suggested by Dr. Snow as an anæsthetic. It is said not to produce complete coma, but to effect a perfect insensibility to pain. (*See* "Medical Times and Gazette," April 4th and 18th, pp. 332 and 381.)

BENZOL—NITRO-BENZOL—ANILINE.

BENZOL (C_6H_6) or (C_6H_5H).

(Hydride of Phenyl—Benzine—Benzine Collas.)

(Sp. gr. of liquid at 16·0° C. 0·885. Boils at 82·0° C.
Freezes at 4·45° C.)

Benzol is obtained during the distillation of coal naphtha. It is a colourless, offensive-smelling liquid, giving off, when heated, a vapour which burns with a white flame, and deposits large quantities of carbon. The vapour is decomposed when passed through red hot tubes. Benzol is insoluble in water, but is soluble in alcohol, ether, turpentine, &c. It freely dissolves strychnia, fatty matters, caoutchouc, gutta percha, camphor, &c., in the cold; and sulphur, phosphorus, and iodine, when heated.

Benzol is an active poison. Severe narcotic effects, accompanied by nervous symptoms, have been noticed when the vapour has been inhaled. There is little difficulty in detecting it, even when present in very small quantity, on account of its offensive smell, whilst its insolubility in water, its inflammability, and the peculiarity of the flame, afford additional tests of its presence.

Its formation, however, into nitro-benzol and aniline at once supplies us with its most important test. Heat a few drops of the *benzol* with a little fuming nitric acid in a test tube. Dilute freely with water, when *nitro-benzol* will be found to separate in the form of oily drops. Dissolve the nitro-benzol thus formed in ether, and decant the ethereal solution. Add to this a mixture of equal parts of hydrochloric acid and alcohol and a few fragments of granulated zinc, when the nitro-benzol will be reduced, and *aniline* formed. Potash must then be added in excess, in order to liberate the aniline, which may then be dissolved out of the mixture by shaking up with ether. If a solution of chloride of lime be added to this ethereal solution, the violet tint, characteristic of aniline, will, either directly, or in a very short time, be developed (Miller). (For further tests, see page 509.)

Poisoning by vapour of Benzol and other Volatile Hydrocarbons.

<table>
<tr><td colspan="3">1.
"Lancet," March 10, 1866, p. 255 (Dr. Gull). Male: æt. 42. Labourer at a gas-tar distillery poisoned by going into a disused tar-boiler where hydrocarbous vapours had accumulated.</td></tr>
<tr><td>*Symptoms.*—This man went into the boiler to help a mate who had fallen down insensible. Delirium afterwards came on; pupils dilated; recovered in 2 or 3 hours, unconscious of what had occurred.</td><td>*Result.*—Recovery.</td><td></td></tr>
</table>

NITRO-BENZOL ($C_6H_5NO_2$).

(Nitro-benzin—Artificial Oil of Bitter Almonds—Essence of Mirbane.)

(Sp. gr. of liquid 1·209. Boils at 220·0° C.)

This is prepared by adding benzol to fuming nitric acid, and warming the mixture, when 1 of the hydrogen of the benzol is replaced by 1 of NO_2. The nitro-benzol is purified by first washing it with water and then with a weak alkaline solution.

Nitro-benzol is a pale yellow-coloured liquid, heavier than water, having a pungent taste and a strong odour of bitter almonds. It must be remembered, however, that it has not the same composition as the natural oil. Nitro-benzol gives none of the reactions of the cyanides or of hydrocyanic acid. It is very soluble in ether, chloroform, and alcohol, but is insoluble in water. It is very combustible, and produces a greasy stain when allowed to fall on paper.

Our knowledge of this, and of aniline poisoning is almost entirely derived from the researches of Dr. Letheby (Proc. Royal Society, 1863, No. 56, p. 556).

Symptoms.

The symptoms, taken either in a liquid or vapourous condition, prove it to be an active poison of a peculiarly insidious nature. Its action, for the most part, is that of a powerful narcotic, whilst it produces, as a rule, but little local irritant action on the stomach or bowels. The vapour, as we have said, may prove injurious, even when very largely diluted with air. It is stated that bad effects have been produced by the use of soap scented with nitro-benzol to give it an almond odour, especially where hot water has been used in washing (" Lancet," Feb. 1, 1862, p. 135).

The cause of death is coma. The coma may be almost immediate in its appearance, or be preceded, as it most often is, by a period of inaction. It is worth noting here (the smell of nitro-benzol and prussic acid being almost identical), that a latent period or a period of inaction of at least two hours, is the rule of nitro-benzol poisoning; whilst with prussic acid, the advent of the symptoms is almost immediate. This period of inaction with nitro-benzol is, no doubt, due to its almost perfect insolubility in water, although even during this latent period a greyish-blue discolouration of the skin has been recorded.

The first symptoms that are usually observed are considerable distress, headache, and drowsiness. These will be followed by flushings of the face, difficult breathing, cardiac irregularity, dilatation of the pupils, more or less complete loss of voluntary power, and, not unfrequently, convulsions. Often, too, the person, on attempting to walk, rolls about as if drunk. The smell of the breath will form in this matter a most important diagnostic sign. Coma may come on slowly, but more often it makes its appearance unexpectedly, gradually increasing in intensity, death usually taking place five or six hours from the first commencement of the symptoms. It may further be added, that when once coma has set in, there is but a very slight chance of any means being successful in recovering the patient.

It is scarcely possible for nitro-benzol to be administered unknowingly, because of its strong persistent odour, and the great discomfort and intense salivation generally induced directly it touches the mouth. The smell of the poison, too, can easily be detected, and this will infallibly serve to distinguish the symptoms from apoplexy, the only thing with which they are very likely to be confounded.

Treatment.

In this there must be no delay. The stomach pump must be used first of all, and the chances are good if it be used at once, because of the insolubility of the poison and its consequent slow absorption. Cold affusion and ammonia are useful; and these, with stimulants cautiously but freely administered, and the usual restoratives, must be persevered in. Transfusion of blood (2 to 3 ozs.) is recommended in bad cases.

Post-Mortem Appearances.

In many cases a distinct colour will be noticed on the skin, or at least on some portions of it. The brain is always found to be congested and the ventricles full of bloody serum. The vessels of the cord are also, as a rule, congested. The blood is everywhere black, and thick, but fluid. The cavities of the heart are full of black treacly blood. The lungs are generally dark coloured, but the stomach is invariably normal. The rigidity is generally well marked and long continued. If death be rapid, probably the smell of the poison in the stomach, brain, and lungs will be easily perceived; but if death be delayed, no smell of nitro-benzol may be detected, nor will analysis be able to prove its presence; but aniline (for reasons we shall explain further on) may most likely be found, and especially in the urine and brain. For these reasons, in suspected cases of nitro-benzol poisoning, the brain and urine should always be particularly examined.

Experiments on Animals.

And here we may notice Dr. Letheby's experiments with nitro-benzol on animals. The effects are divisible under two heads:

1. *Where the poison was speedily fatal.*

In these cases the nervous symptoms set in rapidly, with more or less complete loss of voluntary power. Every now and then the animals had fits of an epileptic nature. They usually lay on their side, and Dr. Letheby remarks that their legs continued in constant motion as if they were running. The pupils were dilated, the breathing difficult, and the heart irregular. Suddenly coma set in, and lasted till death, which occurred in periods varying from twenty-five minutes to twelve hours after the administration of the poison.

2. *Where considerable time elapsed before the symptoms set in.*

For some hours, and even for some days, the animals walked about and took their food as usual. Suddenly they would fall down in a fit, or have an attack of vomiting. After this, paralysis would set in, although perfect consciousness might be retained. This state, after lasting for some days, might end in recovery, or else death result from exhaustion. The epileptic fit in these cases (the first serious symptom) generally occurred about the second day, and death in from the fourth to the ninth.

Temporary salivation in all cases was produced when the poison was administered. Ewald states that sugar may always be found in the urine of the animals ; but it is to be noted that many other things, such as chloroform, chloral-hydrate, and, indeed, all medicines affecting respiration, produce a similar result.

The appearances after death were tolerably uniform, and did not vary materially whether death was slow or rapid. The turgid state of the vessels of the brain and of the membranes, the black fluid blood, the distended gall-bladder, and withal, the natural and uninflamed state of the stomach were the chief things noted. The smell of the poison in the stomach and in other parts, could only be discovered when death took place within twenty-four hours.

The following is a tabular statement of Dr. Letheby's experiments.

Animal.	Dose.	Symptoms.	Post-mortem.
Cat.	ʒss at 1 p.m.	Some discomfort; frothed at mouth; sleep; found dead in the morning.	Brain congested and smelt strongly of poison; blood black and fluid; stomach normal; nitro-benzol and aniline found in stomach.
Small Dog.	ʒss.	In one hour vomited and became sleepy; next morning seemed to have recovered, and ate well all day; the following morning was found insensible, lying on its side, its legs in constant motion; died in three days from exhaustion.	No odour of poison; stomach normal; a trace of aniline, but no nitro-benzol found in stomach.
Small Dog.	ʒj.	Salivation; in 30 minutes there was trembling in the limbs; in five hours convulsions; in six hours coma; limbs constantly moving. Death in seven hours.	Nitro-benzol found in stomach and brain; post-mortem as before.
Dog.	ʒss.	Salivation; trembling of limbs in 1 hour; soon recovered, and remained well for 45 hours, when paralysis came on; lay on its side; legs in constant motion. Death from exhaustion after eight days.	Stomach normal; no trace of poison found.
Cat.	ʒj.	Salivation; in two minutes nervous symptoms set in; in five minutes convulsions and coma. Death in 25 minutes.	Post-mortem as before; nitro-benzol found in every part of the body, and aniline in the stomach and brain.
Large Dog.	45m.	Salivation; for 51 hours seemed well, and then had a convulsive fit and paralysis; remained paralysed for a week, and recovered gradually.	
Large Dog.	ʒj.	Salivation; vomited; appeared quite well for 19 hours, when paralysis set in, from which it suffered so severely that the dog had to be drowned on the fifth day.	No aniline or nitro-benzol found in the stomach.
Dog.	45m.	Salivation; remained well for three days, when paralysis supervened, from which it recovered.	Aniline found in the urine.
Small Dog.	ʒj.	Symptoms commenced in 10 minutes; in 30 minutes it seemed to be drunk; in one hour it had lost all power. Killed at the end of 12 hours.	Nitro-benzol found in all parts, and aniline in the stomach and brain.
Dog.	40m.	Paralysis in 42 hours: up to this time seemed quite well, but then suffered great pain. Killed in 71 hours after taking poison.	No nitro-benzol, but a little aniline found in the brain and urine.

The results of these experiments, conducted as they were with consummate care and ability, are remarkable.

First. They prove that a poison may be retained in the system for days without any ill effects. We had almost learnt to regard the stories of "slow poisoning," and of poisons remaining for a time inert, but able after a while to do their work, as the fanciful inventions of the novel writer and the marvellous monger. But the action of nitro-benzol is almost unique. In Dr. Letheby's own words: "It may be given to-day, and if the dose is not too large, it shall not manifest its action until to-morrow or the day after; and it shall destroy life by a lingering illness, which shall not only defy the skill of the physician, but shall also baffle the researches of the Medical Jurist." This, we need not say, is a rare toxicological circumstance.

Secondly. They prove that the poison may be changed into an entirely different substance: Nitro-benzol in the system becomes aniline. This change is a reduction process; that is, a turning out of oxygen; a passage from $C_6H_5NO_2$ to C_6H_7N. This reduction of nitro-benzol can be effected both by its contact with decomposing organic matter, or, in other words, by the influence of *dead tissue*, as well as by the *living process*, for Dr. Letheby has proved aniline to be present in the urine discharged from the body during life.

And this question here forces itself upon us. Are not the poisoning effects of nitro-benzol really due to aniline—or to put the same question differently, is nitro-benzol a poison at all, unless it becomes changed into aniline? And that this is so, is confirmed by the fact that the symptoms of aniline poisoning are identical with those of nitro-benzol. Dr. Letheby has clearly shown that this is the true explanation of why nitro-benzol may remain in the system inert and powerless, whilst it is when aniline is formed, that the poisonous symptoms of the drug ensue.

But there is a more remarkable circumstance that Dr. Letheby has noticed, and that is the capability of this aniline, formed by this *process of reduction*, to undergo a further change in the body, and to become a new material by a *process of oxidation.* The exhibition of aniline or of its salts, is invariably accompanied by the mauve and magenta tint of the lips and face. Dr. Davies and Dr. Fraser have given cases illustrative of this in the "Medical Times and Gazette" for 1862 (p. 239). But it is to be particularly noticed that whilst this reduction change is an *internal* change, the oxidation change is a *surface* one.

Tests.

1. Odour, consisting of a powerful smell of bitter almonds.

2. To distinguish nitro-benzol from essence of bitter almonds, add to a few drops of the nitro-benzol on a white plate a drop of sulphuric acid. Essence of bitter almonds turns a rich crimson colour, with a yellow border. No change is produced with nitro-benzol.

3. The conversion of nitro-benzol into aniline may be effected by one or other of the following processes.

(*α*) By saturating an alcoholic solution with ammonia, and passing sulphuretted hydrogen through it.
(*β*) By introducing fragments of zinc into a mixture of equal parts of nitro-benzol, alcohol, and hydrochloric acid.
(*γ*) By the action of acetic acid and metallic iron (Béchamp). *Vide* Aniline.

Toxicological Analysis.

In conducting a medico-legal investigation, bruise the matters to be analysed in a mortar and acidulate them with a little sulphuric acid. Distil them in a glass retort, saving and examining the several portions of the distillate from time to time, to discover if possible the presence of any unchanged nitro-benzol. Now treat the materials in the retort with spirits of wine, which will dissolve the sulphate of aniline. Filter. Treat the filtered alcoholic solution with an excess of subacetate of lead, to get rid of gum and other impurities, and again filter. Remove any lead in the filtrate by a slight excess of a solution of sulphate of soda. Filter; evaporate the filtrate nearly to dryness, and make the solution alkaline with carbonate of soda. Dissolve the aniline out by shaking with ether. Add sufficient sulphuric acid to render the ethereal solution acid, and then having distilled off the ether, examine the residue for sulphate of aniline.

This residue must be tested for aniline as follows:—

(*a*) Dissolve the residue in a drop of dilute sulphuric acid (1 to 1), and place the mixture on a piece of clean platinum foil. Connect the platinum with the positive pole of a single Grove's cell, and touch the solution with a platinum wire connected with the negative pole of the battery. Immediately this is done the solution will become of a bronze colour, changing to blue and then to purple. In this way the $\frac{1}{2000}$th part of a grain can easily be recognised.

(*β*) The colour reactions can also be produced by adding a trace of peroxide of lead, or red prussiate of potash, or peroxide of manganese to the acid liquid; but the results are not nearly so delicate nor are they so easily noted as with those produced by the galvanic battery.

(*γ*) If sufficient aniline has been obtained for a further test, add to the liquid a solution of chloride of lime, when a mauve colour, passing rapidly to a dirty brown, will be formed.

As regards the colour-tests it is to be remembered there is some similarity between the results produced by aniline and those produced by strychnia. If, however, the play of colours in the two cases be examined side by side, they will be seen to be very different. And further, note that the salts of strychnia are very bitter, whilst those of aniline are almost tasteless. Organic matter and too much ammonia are the only impediments of any importance to the action of the colour tests.

Cases of Poisoning by Nitro-Benzol.

<table>
<tr><td colspan="3">1.
"Aerzliches Intelligenz-Blatt," Jan. 5, 1875 (Dr. Bruglocher). Male: æt. 40. ʒv taken in 20 times its bulk of spirit (a part at 2 a.m., and the rest at 7 p.m.).</td></tr>
<tr><td><i>Symptoms.</i>—Apparent intoxication, afterwards drowsiness, and finally complete insensibility. At 8.30 complete paralysis set in; skin cyanotic, and the lips violet blue; foamed at the mouth; pupils moderately dilated, insensible to light; urine and fæces passed involuntarily. (Stomach-pump and cold affusion used).</td><td><i>Result.</i>—Recovered in 3 days.</td><td></td></tr>
</table>

2.

"Berliner Klinische Wochenschrift," Jan. 4, 1875 (Dr. Ewald). (1) Female: æt. 21. ʒj. (2) Female: æt. 18. ʒiiss.

Symptoms.—(1) For 5 hours remained insensible; cyanosis well marked.	*Result.*—Recovery.	
Symptoms.—(2) Twelve hours insensible; cyanosis; smell of poison distinct for 3 days in the breath and urine. (Stomach-pump; subcutaneous injection of camphor.)	*Result.*—Recovery.	

3.

"Archiv. der Heilkunde," 1871, p. 320 (Bahrdt), "Wiener Medizin. Wochensch.," No. 12, 1875. Male: æt. 20. Drank a liqueur containing nitro-benzol.

Symptoms.—Vomiting; soon became speechless, from which state he never recovered.	*Result.*—Death in 9 hours.	*Post-mortem.*—Smell of poison apparent in stomach, brain, and heart; all organs of the body congested; lungs very red; right side of heart full of dark thin venous blood.

4.

"Vjhrsshrft," vol. iv., p. 327 (Dr. Schenk). Female: æt. 18. Pregnant. ʒij.

Symptoms.—No effects for a quarter of an hour, when vomiting, followed by giddiness and insensibility, came on; pupils dilated; cyanosis; complete coma (Venæsection). Pregnancy not interfered with.	*Result.*—Recovery.	

5.

"London Hospital Reports," 1865 (Dr. Letheby). Male: æt. 43. The vapour.

Symptoms.—Symptoms set in after about 4 hours; patient seemed as if drunk; had a fit after 6 hours.	*Result.*—Death in 9 hours.	*Post-mortem.*—Post-mortem in 60 hours. Surface of body yellow, the colour being partially got rid of by washing with water; both nitro-benzol and aniline found on analysis.

6.

"London Hospital Reports," 1865 (Dr. Letheby). Male: æt. 17. Sucked a little nitro-benzol into the mouth through a syphon, but immediately spat it out.

Symptoms.—Drowsiness and coma came on in 1½ hour; vomiting; convulsions in 4 hours.	*Result.*—Death in 9 hours.	*Post-mortem.*—Post-mortem after 4 days. Odour of nitro-benzol well-marked; aniline and nitro-benzol found on analysis.

7.

"London Hospital Reports," 1865 (Dr. George Green, Ramsey). Male: adult. Not more than 8 or 9 drops.

Symptoms.—A feeling of suffocation and confusion came on in 1 hour; convulsions in 3½ hours; coma in 6 hours. (Cupping was attempted, but the blood was so thick that it would not run; turpentine enema).	*Result.*—Death in 15 hours.	*Post-mortem.*—Mauve colour of nails well-marked; blood very black.

8.

"London Hospital Reports," 1865 (Mr. Barham, Maidstone). Male: æt. 13. Merely tasted the contents of a bottle.

Symptoms.—Symptoms set in after 6 hours; vomiting; insensibility in 7½ hours.	*Result.*—Death in 10½ hours.	

9.

"London Hospital Reports," 1865 (Mr. Barham, Maidstone). Female: adult. Tasted some nitro-benzol and immediately spat it out—said to have swallowed none.

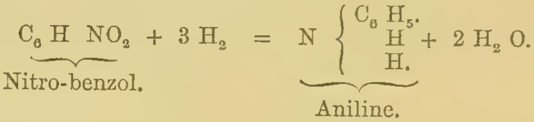
Symptoms.—Vomited after 1 hour, and became insensible. After recovery, for some time, the skin of the face and chest was much discoloured.	*Result.*—Recovery.	

ANILINE ($C^6 H^7 N$).

(Phenylamine.)

(Boils at 182° C. Sp. gr. of liquid 1·028, of vapour 3·210.)

Aniline is prepared from nitro-benzol. The reduction is usually effected by acetic acid and metallic iron (Béchamp). The mixture must be kept stirred, considerable heat being evolved. The aniline and its acetate is then distilled over. The acetate is decomposed by the addition of an alkali, and the mixture purified by distillation. There are several other ways of preparing it, as for instance, by the action of nascent hydrogen.



$$\underbrace{C_6 H\ NO_2}_{\text{Nitro-benzol.}} + 3\,H_2 = \underbrace{N\left\{\begin{matrix}C_6\,H_5.\\ H\\ H.\end{matrix}\right.}_{\text{Aniline.}} + 2\,H_2\,O.$$

It will be seen from the above formula that aniline is an ammonia, where 1 of hydrogen is replaced by 1 of the compound organic radical phenyl ($C_6\,H_5$), and hence aniline has been called phenylamine.

Aniline, when pure, is a colourless liquid, but the commercial samples will generally be found more or less of a reddish brown colour. It has a burning taste, and an unpleasant odour. It is neither soluble in water nor chloroform, but is freely soluble in alcohol, ether, and wood spirit. It produces a greasy stain if allowed to fall upon paper, but the stain so produced rapidly disappears. When exposed to the air it quickly absorbs oxygen, a resinoid mass being formed. The vapour is combustible and burns with a smoky flame. Aniline is a true base, combining, like ammonia, with acids, but it does not, like ammonia, change the colour of red litmus. Nearly all its salts are colourless, crystallize readily, and are soluble in water. Substitution products are formed by the action of chlorine.

Aniline is largely used in the preparation of the numerous coloured dyes, formed by acting upon it with various oxidizing re-agents.

Aniline is a powerful narcotic poison, whether administered in vapour or in a liquid form. We have no fatal case, however, recorded from liquid aniline in the human subject. The salts appear generally to be almost inert, as much as 406 grains of the sulphate having been given to a patient at the London Hospital without much effect. On the other hand, cases are recorded where severe symptoms have been induced by the external application of the hydrochlorate of aniline in cases of psoriasis. And here we may notice a very interesting paper by our colleague, Dr. Morell Mackenzie ("Medical Times and Gazette," March 8, 1862, p. 239), recording a series of cases where sulphate of aniline was given in large doses for rheumatism and chorea, but without any apparent benefit. Similar failures with the same drug are also recorded by Dr. Skinner ("Medical Times and Gazette," March 15, 1862, p. 280).

Symptoms.

The remarks already made about nitro-benzol, apply equally to aniline (p. 506). Given to dogs and cats in doses of from 20 to 60 drops, Dr.

Letheby noted a rapid loss of voluntary power, tonic and clonic convulsions, dilated pupils, difficult breathing, tumultuous cardiac action, intense coma and death in from half an hour to thirty-two hours after administration.

Post-mortem Appearances.

Those described under Nitro-Benzol (page 507), are equally applicable here.

Experiments on Animals.

The experiments of Dr. Letheby, and of others, with aniline on animals may be thus tabulated :—

Animal.	Dose.	Symptoms.	Post-mortem.
Small Dog (Letheby).	ʒj.	Salivation immediate; vomiting in one hour and ten minutes; convulsions in 5¼ hours; in two hours could not stand, and became quite powerless; twitching of limbs; in 26 hours became insensible, and in five hours afterwards died.	Pupils dilated; brain gorged with black blood; abundance of aniline found.
Cat (Letheby).	ʒss.	Great distress from salivation; narcotism in five minutes; a fit in 10 minutes, and afterwards became insensible, and died comatose in four hours.	Post-mortem as usual; aniline found in stomach, brain, liver, and urine.
Cat (Letheby).	20m.	Salivation; in five minutes began to stagger, and bad a fit; in eight minutes became insensible. Died in 38 minutes.	Odour of aniline strong. Poison discovered easily in all the viscera.
Rabbit (Schuchardt).		Death in 6¼ hours.	
Rabbit (Schuchardt).	100m.	Death in four hours.	
Dog (Dr. Turnbull.)	ʒss of Sulphate.	Vomiting in 2½ hours; paralysis of hind legs; in five hours the symptoms abated, and the animal recovered.	

Dr. Kaenser has pointed out that men who work in an aniline atmosphere, often suffer from a bronchial cough and from ulcerations about the scrotum and extremities. The aniline dyes have been credited a good deal with producing a skin irritation of an eczematous character. In such cases we have several times proved that the materials contained a considerable quantity of arsenic acid ("Medical Times and Gazette," Aug. 14, 1869, p. 203; "British Medical Journal," May 3, 1873, p. 424; also, Feb. 27, 1869, p. 191; and March 9, 1869, p. 214). A case is recorded of severe poisoning symptoms being induced in a boy, æt. 13, engaged in working with magenta powder, used in lithographic printing ("Medical Times and Gazette," Sept. 1, 1866, p. 222). We need scarcely add that aniline dyes should, under no circumstances, be employed for confectionery colouring. We have seen bad results from the use of magenta in colouring ices.

For the *Treatment* (*vide* nitro-benzol, page 507).

Tests.

1. Its odour; a peculiar tarry smell.
2. It is combustible and burns with a smoky flame.

3. It turns purple and ultimately black, when acted upon with a solution of chloride of lime.

4. It precipitates gold in a metallic form from a solution of the chloride.

5. When heated with corrosive sublimate, it produces a rich crimson dye.

6. The nascent oxygen tests are by far the most delicate (*vide* Nitro-Benzol, page 510).

In a medico-legal investigation the process detailed at length under Poisoning by Nitro-Benzol is to be adopted (page 507).

Cases of Poisoning with Aniline.

<table>
<tr><th colspan="3">ANILINE.</th></tr>
<tr><td colspan="3">1.
"Medical Times and Gazette," March 8, 1862, p. 239 (Dr. Mackenzie and Dr. Letheby). Male: æt. 16. Engaged in cleaning the inside of a vat used for aniline.</td></tr>
<tr><td>*Symptoms.*—Suddenly seized with giddiness, and seemed as if intoxicated; body pale and cold; semi-sensible; lips and nails of a deep purple colour; pulse scarcely perceptible; vomiting; breath smelt of the poison. Recovered, but the skin was blue the next day, and the breath still smelt of aniline.</td><td>*Result.*—Recovery.</td><td></td></tr>
<tr><td colspan="3">2.
"Medical Times and Gazette," June 7, 1862, p. 583 (Mr. Knaggs). Male: æt. 39. Engaged in chemical works. The patient inhaled fumes of aniline from a broken carboy of the chemical.</td></tr>
<tr><td>*Symptoms.*—Intense perspiration; giddiness rapidly set in; after some time the face and body became of a livid leaden hue; lips bluish; breathing gasping; no convulsions; quite sensible; soon recovered.</td><td>*Result.*—Recovery.</td><td></td></tr>
<tr><th colspan="3">HYDROCHLORATE OF ANILINE.</th></tr>
<tr><td colspan="3">3.
"Medical Times and Gazette," June 21, 1873, p. 660 (M. Lallier). Male: æt. 49. External application for psoriasis, in solution diluted to $\frac{1}{10}$.</td></tr>
<tr><td>*Symptoms.*—Vomiting set in in 1½ hour, incontinence of urine; no diarrhœa; cyanosis after 24 hours. On a second application, there was great drowsiness, shivering, and dyspnœa; cyanosis very marked; voice almost disappeared; recovered in 24 hours.</td><td>*Result.*—Recovery.</td><td></td></tr>
<tr><td colspan="3">4.
"Medical Times and Gazette," June 21, 1873, p. 660 (M. Lallier). Male: æt. 68. External application for psoriasis, solution diluted to $\frac{1}{500}$.</td></tr>
<tr><td>*Symptoms.*—Insensibility and cyanosis in 4 hours.</td><td>*Result.*—Recovery.</td><td></td></tr>
</table>

CARBOLIC ACID ($C_6 H_5 HO$) Phenic Acid—Hydrate of Phenyl—Phenol.

Sp. gr. of liquid 1·065. Boils at 187·8° C. Fuses at 35·0.

Carbolic acid is prepared from coal-tar oil by fractional distillation and subsequent purification. It is met with when pure in perfectly white acicular crystals, which, when kept for some time exposed to the light, assume a reddish magenta tinge. These crystals when exposed to the air attract moisture and liquefy. The merest trace of water in contact with them, rapidly effects this liquefaction of the acid. Carbolic acid, however, is very slightly soluble in water, but is freely soluble in alcohol, ether, glycerine, and glacial acetic acid. It has a burning taste, and a creasote odour. In a liquefied form there is a close resemblance between carbolic acid ($C_6 H_6 O$) and creasote ($C_8 H_{10} O_2$), a wood-tar product, for which carbolic acid is often substituted. Carbolic acid, however, boils at 187·8 C., and does not affect a ray of polarised light, whereas creasote dries up at a temperature of 100·C. Impure or crude carbolic acid produces a jelly-like mass when shaken up with collodion, and is freely soluble in a solution of potash, whilst creasote is unaffected by collodion and is insoluble in a potash solution. It is a powerful *antiseptic*, its action being very energetic in destroying the lower forms of organic life. When employed in fever rooms, it is best to mix it with about 40 or 50 times its bulk of water and thoroughly saturate a quantity of sawdust with the mixture, which can then be conveniently placed about the house on tea-trays. In this way a large surface may be freely exposed to the air. On account of its antiseptic properties, moreover, it is frequently applied to offensive sores. Carbolic acid is also given internally with great advantage in some forms of gastric irritation, accompanied with vomiting. It is not a cumulative poison, for it is as rapidly excreted as it is quickly absorbed.

Symptoms, Dose, &c.

There is usually immediate vertigo and intoxication, accompanied by an intense burning pain from mouth to stomach, occasionally with vomiting of frothy mucus. Vomiting, however, is not common. The mouth is white and hardened from the local action of the acid. The pupils are invariably contracted. The pulse will be found rapid and intermittent; the breathing difficult, jerky, and stertorous, and the breath smelling strongly of the acid; the skin cold and clammy; and any urine passed, (for often there is complete suppression), dark coloured and smoky, a change due to the oxidation of the acid in the kidneys. After a time, perfect insensibility passing into intense coma, supervenes, convulsions being a rare, but an occasional symptom. Death may be rapid, that is, within an hour, from syncope; or it may be prolonged, when it will be probably due to apnœa. Cases, moreover, are recorded where the patient for a time seems to recover from the active symptoms, and then has a relapse and dies suddenly. Paralysis, too, is occasional. The records of cases show that the chances of recovery after a poisonous dose has been taken are small. Death usually occurs in from thirty minutes to four hours, ten minutes being the shortest recorded period, and sixty hours the longest.

Dangerous symptoms may be produced by doses of 6 or 7 drops. The deaths on record, however, have generally been caused by doses such as 1 or 2 ounces, which of course are far in excess of what is needed to destroy life. Its external application, as well as its use as an injection, have proved fatal ("British Medical Journal," Feb., 1868).

Treatment.

The treatment must consist in the administration of emetics of mustard and water, or of sulphate of zinc. Owing to the insolubility of the acid, a good deal may in this way be got rid of. Albumen (uncooked eggs) should be given *ad libitum*, and collapse be treated by the injection of stimulants. A mixture of olive and castor oils with magnesia in suspension may also be given with advantage (*see* "Medical Times and Gazette," May 30, 1868, p. 589). Dr. Hasemann states that saccharate of lime is an antidote to the poison ("Medical Times and Gazette," December 9, 1871, p. 707).

Dr. Sansom advocates the use of the stomach-pump. There is this to be said in its favour, that the cases are usually so desperate that the only hope seems to consist in very active treatment. Still, we feel bound to insist on the necessity of more than ordinary care in its employment.

Post-mortem Appearances.

The mouth and œsophagus are usually white, soft, and corroded, but sometimes hardened and shrivelled. The brain is generally normal, but occasionally congested, a fluid having a strong smell of the acid, being found in the ventricles. The lungs are usually gorged with blood. The state of the heart varies. Most often both sides have been found empty; occasionally both sides are full of dark blood, and at other times the left side only. The stomach is most often found white, contracted, thickened, and shrivelled; but sometimes it is intensely congested, and the mucous membrane destroyed; whilst occasionally no abnormal change is noted. The intestines are usually more or less thickened and congested. The mouths of the follicles of the colon are said to be often abraded. The bladder is generally quite or very nearly empty, any urine present being of a dark colour. The blood is usually more or less fluid and dark coloured.

Action on Animals.

The action of carbolic acid on animals is curious. Tetanic convulsions, which are not common symptoms in man, are general when the acid is administered to animals. Often these convulsions are followed by a state of paralysis and collapse. Local and general paralysis results when the acid is injected into the blood, the muscles shrinking, and not afterwards affected by galvanic shocks. Salivation and dilatation of the pupils are usual (Salskowski and Hoppe-Seyler).

Tests.

1. Odour; this is the most delicate of all tests.
2. It does not redden blue litmus.

3. It produces a transient greasy stain on paper.
4. It coagulates albumen.
5. A splinter of wood moistened with the acid, and afterwards dipped into nitric or hydrochloric acid, turns of a greenish blue tint when dry.
6. If the acid be mixed with one-fourth its volume of liq. ammoniæ, and a trace of a solution of a hypochlorite added, and the mixture gently warmed, the liquid assumes a blue colour. If this be acidulated, it turns red (Salskowski).
7. *Bromine water* produces a whitish-yellow flocculent precipitate. If this precipitate be treated with sodium amalgam, carbolic acid is set free (Landolt).

Toxicological Analysis.

If, in conducting a medico-legal examination, no smell of carbolic acid can be detected, no other tests are likely to be of any avail. The distillation of the organic matters mixed with dilute sulphuric acid is all that is necessary for the recovery of the acid. In examining the urine, it is preferable to distil it without adding any sulphuric acid, as it is stated that sulphuric acid may develop phenol from its action on some bodies existing normally in urine.

Cases of Poisoning with Carbolic Acid.

<table>
<tr><td colspan="3">1.
Husemann's "Jahresbericht," 1872, p. 523. Adult. One or two tablespoonfuls.</td></tr>
<tr><td></td><td><i>Result.</i>—Death in 50 minutes.</td><td></td></tr>
<tr><td colspan="3">2.
"Lancet," Jan. 30, 1869, p. 179 (Mr. Anderson). Male: æt. 64. Suffering from fractured thigh. ʒj of pure acid taken by mistake for medicine. Taste not noticed whilst it was being swallowed.</td></tr>
<tr><td><i>Symptoms.</i>—Symptoms set in after 10 minutes; mouth whitened. In 5 hours there was great pain, with convulsive twitchings; pupils contracted; mind clear. After 8 hours seemed a little better, and in 12 hours died.</td><td><i>Result.</i>—Death in 12 hours.</td><td></td></tr>
<tr><td colspan="3">3.
"Lancet," March 20, 1869, p. 395 (Mr. Swain). Female: æt. 30. ℥iss of impure acid.</td></tr>
<tr><td><i>Symptoms.</i>—Drank the acid without noticing its taste. Immediate pain; lips and tongue became white; insensibility in 8 minutes; death in 1 hour.</td><td><i>Result.</i>—Death in 1 hour.</td><td><i>Post-mortem.</i> — Stomach congested, having a greenish stain; smell of acid apparent in all internal organs, especially in the liver, spleen, and kidneys, and in the intestines as far down as the middle of the ileum.</td></tr>
<tr><td colspan="3">4.
"Lancet," Sep. 18, 1869, p. 401 (Dr. Barlow). Male: æt. 60. (?) Probably about ℥ss.</td></tr>
<tr><td></td><td><i>Result.</i>—Death in 10 minutes.</td><td><i>Post-mortem.</i>—Mouth white and hardened; brain normal; heart quite empty; stomach contracted; coats thickened; mucous membrane in ridges, which were white on the summit, but pink in the furrows; intestines normal; bladder empty.</td></tr>
</table>

5.

"Lancet," Jan. 4, 1873, p. 14 (Dr. Way). Female. Less than ℥viii.

Symptoms.—Death, without a struggle, from syncope.	*Result.*—Death.	*Post-mortem.*—All internal organs smelt of carbolic acid; pyloric orifice of stomach thickened; the stomach, and 50 inches of the intestines were thickened and of a bluish white colour.

6.

"Lancet," March 1, 1873, p. 302 (Mr. Brabant). Female: æt. 44. ʒj of impure acid.

Symptoms.—Intense dyspnœa; coma.	*Result.*—Death in 50 minutes.	*Post-mortem.*—The mucous membrane of the mouth, stomach, and œsophagus was soft and white above, and underneath bright red; a few congested patches were found on the duodenum only; blood fluid; no smell of the acid noticed anywhere but in the stomach.

7.

"Lancet," June 7, 1873, p. 821. Female. Used as an injection for the vagina.

Symptoms.—Severe symptoms.	*Result.*—(?).	

8.

"Lancet," June 21, 1873, p. 876 (Dr. Russell). Female: æt. 7. ℥ss of acid mixed with water and glycerine.

Symptoms.—Insensibility in 10 minutes; pupils contracted; coma.	*Result.*—Death in 1½ hour.	*Post-mortem*—Bladder contained ½oz. of urine, and smelt strongly of the acid; no albumen; no peculiar appearances were noticed in the mouth, œsophagus, stomach, or 2 inches of duodenum; but the small intestines for 3 feet were covered with a white eschar; the brain was congested, and smelt of the acid; blood fluid.

9.

"Lancet," Nov. 9, 1872 (Dr. Tayne). Male: æt. 4½. (?).

Symptoms.—Convulsions; frothing at mouth.	*Result.*—Recovery.	

10.

"American Practitioner," May, 1873 (Dr. Cowling). Female. A tablespoonful of pure acid in twice its bulk of water.

Symptoms.—In 10 minutes there was insensibility; pupils contracted; mouth and throat whitened. (Stomach-pump, whisky, and oxygen-gas were used!)	*Result.*—Death in 2 hours.	

11.

"British Medical Journal," Feb. 4, 1871, p. 116 (Dr. Ogston). Male: æt. 47. ʒj—ʒij of crude acid.

Symptoms.—Insensibility; stertorous breathing; pupils very contracted. Became after a time slightly conscious. Dark-coloured urine passed.	*Result.*—Death in 13½ hours.	*Post-mortem.*—Post-mortem in 32 hours. Mouth smelt of the poison; membranes of brain congested and serum found in the ventricles which smelt of the poison; mouth, throat, and gullet white and sodden; stomach almost normal, but covered in some parts with hard, reddish, elevated spots; intestines natural; both sides of the heart were full of dark, clotted blood; blood everywhere clotted.

12.

Virchow and Hirsch's "Jahresber. F.," 1871, vol. i., p. 337 (Dr. Zimm). ℥j of crude acid by mistake for cognac.

	Result.—Death in 60 hours.	

13.

"British Medical Journal," Jan. 24, 1874, p. 110 (Mr. Stocks). Female: æt. 30. A dose of strong impure acid.

	Result.—Death in 4 hours.	*Post-mortem.*—Mucous membrane destroyed both in the mouth and in the upper part of the œsophagus; in the lower part it was of a whitish colour; mucous membrane of stomach also destroyed.

14.

"Medical Times and Gazette," April 15, 1871, p. 423 (Messrs. Jeffreys and Hainworth). Male: æt. 65. From ℥ss to ℥j.

Symptoms.—Insensibility; pupils contracted; respiration laboured and irregular.	*Result.*—Death in 50 minutes.	*Post-mortem.*—Mouth, tongue, and œsophagus white, firm, and corrugated; stomach white and shrivelled; right side of the heart empty; the left side containing a little fluid blood; all the viscera congested; the arachnoid appeared opaque, and contained a quantity of fluid.

15.

"British Medical Journal," Feb. 10, 1872, p. 169 (Mr. Harley). Male. ℥j taken by mistake.

Symptoms.—Soon became comatose.	*Result.*—Death in 4½ hours.	*Post-mortem.*—Tongue, mouth, and fauces appeared white.

16.

"British Medical Journal," Feb. 10, 1872, p. 169 (Mr. Harley). Female. ℥vss.

	Result.—Death in 2½ hours.	

17.

"Medical Times and Gazette," April 25, 1868, p. 456 (Mr. Sutton). Female: æt. 43. ℥j of the crude acid.

Symptoms.—Insensibility in 5 minutes; pupils contracted; respiration stertorous.	*Result.*—Death in 1½ hour.	*Post-mortem.*—Interior of mouth white; tongue dry; mucous membrane of stomach brown, dry, and shrunken; both ventricles of the heart empty—the mucous membrane of the stomach easily peeled off and was very inflamed, with white patches; the duodenum in a similar state; brain healthy.

18.

"British Medical Journal," Feb. 15, 1873, p. 167 (Dr. Ferrier). Male: æt. 7. Quantity probably not large.

Symptoms.—Stupor; stertorous breathing; contracted pupils; saliva flowed from the mouth.	*Result.*—Death in 8 hours.	*Post-mortem.*—Brain normal; sinuses distended with dark fluid blood; carbolic acid odour in the thorax very distinct; lungs congested; heart empty; left ventricle very contracted; mucous membrane of the mouth, throat, œsophagus, and stomach white, sodden, and corrugated; smell of poison distinct as far as the upper part of the jejunum; kidneys smelt strongly of the acid; also the urine, but it contained no albumen.

19.

"British Medical Journal," March 1, 1873, p. 226 (Mr. Hamilton). Female: æt. 4½. Carbolic acid applied to a wound.

Symptoms.—Complete coma.	*Result.*—Death in 3½ hours.	

20.

"British Medical Journal," May 24, 1873, p. 584 (Dr. Hearder). Male: æt. 36. About ʒj.

Symptoms.—In 5 minutes there was intense pain; gasping respiration, and attempts to vomit; then succeeded insensibility; no convulsions, tetanus, or stertor, but paralysis of all the voluntary muscles.	*Result.*—Death in 30 minutes.	*Post-mortem.*—Lips and chin excoriated; brain healthy; dura mater much congested; cavities of the heart full of dark fluid blood; mucous membrane of œsophagus white; stomach and intestines softened.

21.

"British Medical Journal," May 31, 1873, p. 611 (Dr. Biddle). Male: æt. 72. Sucked some carbolic acid from a sponge.

Symptoms. — Insensibility; vomiting not produced.	*Result.*—Death in 4 hours.	*Post-mortem.*—Brain healthy; membranes much congested; pharynx and stomach softened and corroded; the odour of the poison was traced as far as the cœcum.

FUMES OF CARBOLIC ACID.

22.

"British Medical Journal," Nov. 23, 1872, p. 579. Male: adult. Exposed to the fumes of the acid for three hours.

Symptoms.—Convulsions; coma.	*Result.*—Recovery.	

DISTILLED TAR.

23.

"Medical Times and Gazette," June 29, 1867, p. 727 (Dr. Watmough). Male: æt. 71. Three-quarters of a pint taken instead of beer.

Symptoms.—Very soon afterwards was unable to stand; suffered very little pain.	*Result.*—Death in 2 hours.	

Other Cases of Poisoning by Carbolic Acid are recorded as follows:—

"British Medical Journal," Feb. 8, 1873, p. 151. (Death.)
,, Feb. 22, 1873, p. 203. (Death. Female: æt. 40.)
"Medical Times and Gazette," June 20, 1874, p. 679. (Given by mistake.)
"British Medical Journal," April 30, 1870, p. 432. (Poisoning symptoms from absorbing the poison.)
,, Oct. 26, 1872, p. 472. (Convulsions; insensibility. Recovery.)
,, July 4, 1874, p. 17.
,, Oct. 8, 1870. (Death from external application.)
"Pharmaceutical Journal," July, 1872, p. 75. (Death in 30 minutes.)
"Guy's Hospital Reports," 1867, p. 233. (Death in 12 hours from taking 2 teaspoonfuls of the acid. Æt. 2.)

BISULPHIDE OF CARBON, CS_2.

Sp. gr. 1·26. Boils at 45° C.

Bisulphide of carbon is prepared by burning carbon in sulphur vapour. It is insoluble in water, and freely dissolves phosphorus, sulphur, and caoutchouc. It burns with a pale blue flame, and gives off at ordinary temperatures a nauseous offensive vapour, which produces injurious effects on the general health of the workpeople exposed to its influence ("Chemical News," May, 1863, p. 216).

Chronic Poisoning.

The extensive use of bisulphide of carbon in india-rubber manufactories, renders the subject of chronic poisoning by the vapour, of considerable importance from a hygienic point of view. The principal investigations on the subject are those of Delpech. He finds that it causes in the first instance headache, vertigo, and a great excitement of the nervous system. As the case progresses the patient talks incessantly, sings constantly, and laughs or weeps immoderately. This state, if not actively dealt with, may proceed even to complete lunacy. Dr. Delpech considers that the only method of preventing the evil is by erecting between the workmen and the worktable, a glass screen having holes in it through which the arms of the workmen may be placed.

Action on Animals.

M. Cloëz has carefully examined the effects of bisulphide of carbon on animals. Rats and rabbits exposed to the action of the vapour, after a few minutes of quietude, rushed about with great violence. Convulsions then set in, after which they fell on their side, breathing slowly, and died usually in five minutes from the commencement of the experiment. The lungs after death were generally congested, but there was no lesion of the brain, and both sides of the heart were full of blood. There can be no difficulty in detecting bisulphide of carbon by its singularly nauseous odour, and by the great inflammability of its vapour.

CHLORAL (TRICHLORACETYL) - $C_2 Cl_3 HO$.
HYDRATE OF CHLORAL - - - $C_2 Cl_3 HO, H_2 O$.
BROMAL - - - - - - $C_2 Br_3 HO$.

Chloral is produced by passing dry chlorine through absolute alcohol ($C_2 H_6 O$) to saturation, whereby the alcohol first loses 2 atoms of hydrogen ($C_2 H_4 O$ = aldehyde), 3 of the hydrogen of this compound being afterwards replaced by 3 of chlorine ($C_2 Cl_3 HO$ = chloral). Hydrochloric acid is liberated and chloral is found in solution. *Bromal* is similarly prepared, bromine being substituted for chlorine. Rabuteau considers that he has prepared a corresponding iodine compound, but of this there is some doubt. On adding to the chloral solution a little water, the hydrate is thrown down, considerable heat being given out at the same time.

Chloral hydrate is a white crystalline solid, having a pleasant odour but an unpleasant taste. By heat it may be entirely volatilized, and distilled unchanged. It is soluble in water, alcohol, ether, and in bisulphide of carbon, and it is also freely dissolved by sulphuric and nitric acids. If a trace of potash be added to a boiling solution of the salt, chloroform and formic acid (formate of potash) are produced. (100 parts of hydrate of chloral will yield 82 parts of chloroform). A salt of copper is decomposed by it, the action being similar to that of grape sugar, whilst a salt of silver or gold is reduced when boiled with it and potash.

Symptoms, Dose, &c.

Chloral is "a hypnotic," that is, it induces normal sleep; the headache, nausea, and constipation of opium narcotism, not occurring as after effects. The pulse and breathing are not affected.

But chloral may act as a poison. What dose is poisonous, is hard to say. Bad symptoms have resulted from doses of 7 and 9 grains. Death has followed the exhibition of 30 grains, whilst 150 and 180 grains ("Lancet," Nov. 26, 1870, p. 742), and even much larger quantities have been taken without ill effects. These facts prove the necessity of care when chloral is first administered to a patient. But more than this; in days when ladies take chloral of their own accord for every conceivable ailment, and when young ladies are known "to regard it as an agreeable restorative after the excitement of a ballroom," it is necessary clearly to bear in mind, that small doses with some may prove a risk, as with others they may be a benefit. It must not be played with as if it were a glass of sherry.

The other symptoms that have been noticed in cases of poisoning are violent cramps in the legs, and extreme lividity of the face and hands. Convulsions are very rare. The pupils during sleep are usually contracted, but to no marked extent. On waking they dilate. Often, too, a scarlatinal rash more or less general, or a rash, at times having the character of purpura, has been noticed. The patient, too, frequently will complain of sharp pains in the head, and stinging sensations over the surface of the body. A slight amount of stimulation of the salivary glands is not infrequent. Cases, too, are on record showing its influence on cardiac innervation ("Lancet," April 8, 1871, p. 474). The conjunctivæ often appear very red and the lips hard. A peculiar falling of the lower jaw has been more than once noticed.

The time of death varies from one hour to three days.

The fatal result is supposed to be brought about by the alkaline state of the blood converting the chloral into chloroform and formic acid, and there are good reasons for believing this view to be correct.

Treatment.

Dr. Bence Jones strongly urges strychnia as the antidote in chloral poisoning ("Medical Times and Gazette" Aug. 14, 1869, p. 203). We should rather recommend—

1. To get rid of as much of the poison as you can from the stomach by emetics and by the stomach-pump.
2. To dilute what may be left, by the free administration of tea, coffee, or weak rum.
3. To restore the respiration.

If the case be very severe, transfusion of blood may be needful.

Post-mortem Appearances.

Considerable congestion of the cerebral vessels has been noticed in post-mortem examinations.

Toxicological Analysis.

In conducting a medico-legal examination, render the contents of the stomach alkaline with potash, and heat the mixture in a retort by the aid of a water bath, testing the vapours for chloroform in the manner described (page 527).

The physiological action of *bromal hydrate* ($C_2 Br_3 HO, H_2 O$) (a far more energetic drug than chloral hydrate) has been investigated by Rabuteau, Steinauer, and Dougall. Three grains, these experimenters agree, subcutaneously injected, will kill a rabbit in one to two hours. The symptoms set in after from three to four minutes, and consist of an extraordinarily profuse secretion from the mouth, nose, and eyes, together with paralysis, convulsions, and often opisthotonos. Chloral hydrate, it may be noted, rarely produces convulsions, and does not produce marked pupillary contraction, as bromal hydrate is found to do. After death by bromal, fluid is invariably found in the closed sacs of the body, which is not the case with chloral.

(For further particulars, *see* "Edinburgh Medical Journal," July, 1874).

Cases of Poisoning with Chloral Hydrate.

<table>
<tr><td colspan="3">1.
"Lancet," July 13, 1872, p. 68 (Dr. Diver). Male: adult. Nine grains.</td></tr>
<tr><td><i>Symptoms.</i>—Soon became very cold, and his teeth fixed. Next morning had a pale look.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">2.
"Lancet," July 13, 1872, p. 68 (Dr. Diver). Female: æt. 68. Seven-and-half grains.</td></tr>
<tr><td><i>Symptoms.</i>—In 2 hours woke up in a semi-conscious state, and after a time had epigastric pains.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">3.
"Lancet," Dec. 7, 1872, p. 826. Male: adult. Four hundred grains taken in the course of two days.</td></tr>
<tr><td><i>Symptoms.</i>—Found dead in his bed in the morning.</td><td><i>Result.</i>—Death.</td><td></td></tr>
<tr><td colspan="3">4.
"Lancet," March 25, 1871, p. 403 (Dr. Fuller). Male: adult. Thirty grains. Patient was suffering from bronchitis and anasarca.</td></tr>
<tr><td><i>Symptoms.</i>—Delirium and extreme depression.
A second dose was administered, taking care that no alkaline medicine was administered previously, but the same symptoms occurred.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">5.
"Lancet," March 25, 1871, p. 403 (Dr. Fuller). Female: æt. 20. Thirty grains.</td></tr>
<tr><td><i>Symptoms.</i>—Immediate excitement; but afterwards fell asleep. In the morning could not be roused, and was pulseless, and sighing heavily. Stimulants were administered. Consciousness never returned, and the patient never moved, after going to sleep.</td><td><i>Result.</i>—Death in 35 hours.</td><td></td></tr>
</table>

6.

"Lancet," April 8, 1871, p. 473 (Dr. Crichton Browne). (1) Female: æt. 69. Twenty grains three times a day. (2) Female: æt. 46. Fifteen grains three times a day. (3) Male: æt. 46. Thirty grains every night for 10 months.

Symptoms.—(1) Erythematous blush; bad symptoms.	*Result.*—Recovery.	
Symptoms.—(2) An eruption like purpura.	*Result.*—Death.	
Symptoms.—(3) Vaso-motor paralysis induced.		

7.

"Lancet," Feb. 18, 1871, p. 226 (Dr. Norris). Female: æt. 46. 712 grains taken during nine days, the last 260 being taken during 35 hours.

Symptoms.—Vomiting.	*Result.*—Death.	*Post-mortem.*—All tissues very firm, brain not congested; no fluid found in the ventricles; stomach not decomposed; chloral found, mostly in the liver and stomach.

8.

"Lancet," Sep. 30, 1871, p. 466 (Dr. Smith, Maryland). Several cases of death from chloral taken medicinally.

Symptoms.—In 2 cases the symptoms were instantaneous, and in 1 after 3 hours.		

9.

"Medical Times and Gazette," April 1, 1871, p. 367.

	Result.—Death.	

10.

"British Medical Journal," Jan. 11, 1873, p. 43 (Dr. Thompson). Female: æt. 27. 180 grains.

Symptoms.—Wild delirium after 2 hours, but ending in a quiet sleep and recovery.	*Result.*—Recovery.	

11.

"British Medical Journal," Feb. 25, 1871, p. 193 (Dr. Hunt). Male: æt. 51. Quantity (?).

	Result.—Death.	*Post-mortem.*—Post-mortem in 54 hours. Heart normal; lungs healthy; stomach in parts congested; intestines natural; membranes of the brain congested; no effusion into the ventricles.

12.

"Medical Times and Gazette," Dec. 12, 1874, p. 672 (Mr. Hulke). Female: æt. 23. Four ozs. of syrup of chloral hydrate.

Symptoms.—Soon became insensible, breathing stertorous, pupils contracted; breathing at last became so feeble that artificial respiration had to be resorted to (stomach pump used, and coffee injected). In 40 minutes became conscious. Afterwards became insane.	*Result.* Recovery.	

CHLOROFORM ($C\,H\,Cl_3$).

Boils at 60·16 C. Sp. gr. of liquid 1·497, and of vapour 4·2.

Chloroform is prepared by distilling chlorinated lime with spirits of wine diluted with 16 times its bulk of water. The distillate may then be purified by shaking first with water, and afterwards with sulphuric acid, by which means various hydrocarbons will be got rid of. The acid must be then neutralized with lime, and the water removed by desiccation with chloride of calcium. Wood spirit, oil of turpentine, and other bodies may also be made to yield chloroform.

Chloroform is a colourless, very volatile liquid, having an apple odour, and a pungent taste. Optically it is highly refractive. It inflames with difficulty, the flame being green and smoky. It is very soluble in alcohol and in ether, but very sparingly so in water (1 in 10,000). It freely dissolves camphor, wax, resins, caoutchouc, sulphur, phosphorus, bromine, iodine, and some of the alkaloids, as strychnia. It is not readily attacked by acids, and has itself no action on metals or on organic matter. By passing the vapour through a red hot tube, it is decomposed, hydrochloric acid being formed if moisture be present.

The great use of chloroform is as an anæsthetic. Accidents from its use are comparatively rare (1 in 2,500, Dr. Richardson), although sufficiently common to render its use, in our opinion, unjustifiable in ordinary midwifery and in minor operations. There are certain definite rules to be borne in mind in its administration.

1. It should be avoided in patients suffering from certain cardiac diseases.
2. It should be given upon nearly an empty stomach.
3. The vapour should never be more concentrated than 1 part in 100 of air.
4. It should never be administered to a patient in a sitting posture.
5. During its administration the effects should be carefully watched on—
    (a) the pulse; and
    (β) the face. If the lips or face turn blue, its administration should be at once discontinued.

A question of some importance to the medical jurist naturally occurs here, namely, *whether chloroform can be administered for improper purposes.* We know, however, that comparatively, the insensibility from chloroform vapour is only slowly induced. It would be difficult, therefore, to administer chloroform to persons forcibly and against their will, whilst, of course, the stories of immediate anæsthesia produced by it are but idle fables. Still, it might be administered to persons asleep without much difficulty ("Lancet," Oct. 5, 1872, p. 514, and Oct. 12, 1872, p. 549), and this seems the only possible condition under which it could be conveniently used for improper purposes, unless considerable force was employed to prevent the person struggling, which, under ordinary circumstances, would be an almost insurmountable difficulty to its use.

Tests of Purity.

NOTE.—The purity of chloroform is a matter of great importance. It may be that many of the unfortunate accidents that have occurred from it are due to impurities in the drug. Note—

1. It should have no action on litmus paper.
2. Mixed with white of egg there should be no signs of coagulation.

3. There should be no precipitate with nitrate of silver.

4. There should be no blackening when shaken up with sulphuric acid.

5. It should be perfectly colourless. (When kept for some time exposed to a strong light it undergoes spontaneous decomposition).

6. It should give off no chlorous or unpleasant odour when a few drops are put on the hand and allowed to evaporate.

Symptoms, Dose, &c.

In a *liquid form,* chloroform does not seem to exert a very poisonous action. Deep coma, dilated pupils, slow pulse, and cold skin, are the ordinary symptoms. Sometimes there is vomiting. Convulsions or delirium are not recorded. A dram is said to have proved fatal in three hours in a child four years old. Dr. Collins records a case of poisoning in an adult by about 1 oz. in eighteen hours.

The action of *chloroform vapour* is more important than that of the liquid. Five distinct effects are detailed by Druitt in the order of their appearance :—1. *Exhilaration*; 2. *Drowsiness*; 3. *Profound sleep* with contracted pupils; 4. *Perfect insensibility*; 5. *Coma*, with slow breathing and dilated pupils. The causes of death after its inhalation for operations are various. It may be due to the shock of the operation, or to the chloroform being administered in too concentrated a form. Impurities in the chloroform, or want of due care in its administration, may account for some cases, and disease of the brain and of the heart for others. Still, there are cases of death that we cannot account for, some where the quantity breathed has been extraordinarily small (such as 15 minims), and administered with great care, and others where its exhibition has been discontinued some minutes before the fatal result.

Treatment.

When *the liquid* has been taken, the stomach-pump should be at once used. In poisoning by *the vapour*, the treatment should consist in the cold douche, fresh air, galvanism, artificial respiration, and in the application of ammonia to the nostrils. It is advisable, moreover, to see that the tongue is well forward, so that nothing may interfere with free access of air to the lungs, as well as to avoid giving liquids until the patient has fairly recovered.

Post-Mortem Appearances.

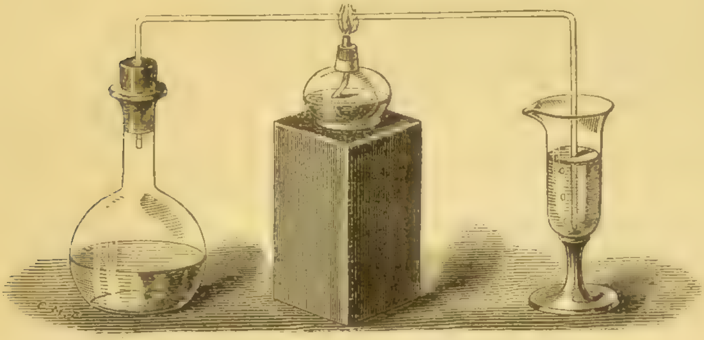
Generally all the cavities of the heart are distended, whilst exceptionally the left side is empty. The countenance is livid and pale, and putrefaction is usually somewhat slow.

Toxicological Analysis.

In a medico-legal examination, first endeavour to detect the odour of the poison. Chloroform is not so strong smelling as ether, and is much more volatile. It is more readily detected in the lungs than in any of the other viscera. It must not be supposed, however, that analysis, failing to prove the presence of the poison, justifies us in coming to the conclusion that death was not caused by it, inasmuch as its absence may be accounted for by two circumstances, (1) its ready volatility, and (2) its conversion in the body into formic acid.

(*a*) The contents of the stomach and the tissues should be placed in a flask fitted with a bent hard glass tube, dipping under a solution of nitrate of silver (Fig. 42) The tube should then be heated in the centre to bright redness, after which heat should be applied to the flask by the agency of a water bath. If chloroform vapour be present, it will be resolved as soon as it comes in contact with the hot tube, into chlorine and hydrochloric acid, and these will produce a precipitate with the silver salt.

FIG. 42.



(β) Test for an acid at the end of the tube with litmus paper.

(γ) Hold at the end of the tube a piece of paper moistened with starch and iodide of potassium. This will be turned blue if chloroform be present, from the chlorine setting free the iodine, and its reaction on the starch.

Cases of Poisoning with Chloroform (liquid).

1. “Medical Times and Gazette,” May 10, 1862, p. 478 (Dr. Axel Lamm). Male: æt. 35. A considerable quantity.		
Symptoms.—Usual symptoms. Pupils at first dilated. Reaction set in, and soon afterwards he died.	*Result.*—Death in 12 hours.	*Post-mortem.*—Brain congested; stomach congested towards the cardiac, but pale towards the pyloric end; mucous membrane of intestines paler than usual.
2. “Medical Times and Gazette,” May 31, 1862, p. 577. Male: æt. 50. ℥ij.		
Symptoms.—Deep coma; breath smelt strongly of the poison; pupils dilated, and insensible; pulse slow, and the surface of the body cold. Remained insensible for 7 hours.	*Result.*—Recovery.	

3. "Medical Times and Gazette," Jan. 13, 1866, p. 34 (Dr. Collins). Male: æt. 25. About ℥j. (S. G. 1486.)		
Symptoms.—No urine passed; insensibility.	*Result.*—Death in about 18 hours.	*Post-mortem.*—Brain natural, but the membranes congested; heart large and soft—the left cavities empty, the right side full of dark coagulated blood; lungs congested; stomach empty, contracted, and inflamed towards the cardiac end. There was no smell of the poison.
4. "Medical Times and Gazette," Nov. 5, 1864, p. 507. Male: æt. 27. Twelve and a half drams taken internally.		
Symptoms.—Vomiting; speedy and complete insensibility; pupils very dilated. For three hours the case looked hopeless, but during the fourth hour the pulse rallied, and he soon recovered. There were no convulsions or delirium.	*Result.*—Recovery.	
5. "Medical Times and Gazette," Oct. 10, 1863, p. 378 (Dr. Woodman). Male: æt. 72. Olive oil and chloroform—about ℥ss of each.		
Symptoms.—Soon became excited, then insensible; pupils contracted.	*Result.*—Recovery.	

OIL OF DIPPEL,

(Oil of Hartshorn.)

This is an oil produced as a product of the distillation of animal matters, such as bones, blood, &c.

When respired it produces narcotic symptoms, the vapour being intensely offensive, and very irritating to the eyes. It acts as a violent poison when swallowed.

Cases of Poisoning with Oil of Dippel.

1. Chaussier's "Toxicologie," p 395. (?): adult. A teaspoonful.		
	Result.—Death immediate.	
2. "Dictionaire de Science Médicale," vol. xxi., p. 605 (Christison). Female: adult. ℥iss.		
After taking it drowned herself.		

ETHER ($C_4H_{10}O$).

(Boils at 35·6 C.: sp. gr. of liquid at 15·5 C. = 0·736.)

Preparation and Properties.

Ether is usually prepared by acting on alcohol with strong sulphuric acid. Two reactions are said to take place.

1. Water and sulphethylic acid are formed—

$$\underbrace{C_2H_6O}_{\text{Alcohol.}} + \underbrace{H_2SO_4}_{\text{Sulphuric Acid.}} = \underbrace{H_2O}_{\text{Water.}} + \underbrace{C_2H_6SO_4.}_{\text{Sulphethylic Acid.}}$$

2. This sulphethylic acid reacts on the excess of alcohol, forming ether and sulphuric acid—

$$\underbrace{C_2 H_6 O}_{\text{Alcohol.}} + \underbrace{C_2 H_6 SO_4}_{\text{Sulphethylic Acid.}} = \underbrace{C_4 H_{10} O}_{\text{Ether.}} + \underbrace{H_2 SO_4}_{\text{Sulphuric Acid.}}.$$

It will be noticed that the sulphuric acid being reformed, a small quantity of the acid should theoretically convert an unlimited quantity of alcohol into ether. As a matter of fact, however, the power of the acid is limited, owing to the occurrence of secondary reactions and its contamination with the impurities of the alcohol.

The ether is collected by suitable condensers. The water which comes over with it, separates spontaneously. The sulphurous acid present in the ether is removed by washing with caustic soda, and the alcohol by washing in salt water in which alcohol is more soluble than ether. The washed ether is once more distilled with solid chloride of calcium and caustic lime.

Ether is a colourless, mobile, highly refractive liquid, having a warm taste, and an agreeable "ethereal" smell. From the rapidity with which it evaporates, it produces great cold, and consequent local anæsthesia when applied to the skin. This is the principle of the ether spray of Dr. Richardson.

It catches fire easily, burning with a white luminous flame. The ether vapour is about two and a half times heavier than air.

Water dissolves about one-tenth its bulk of ether. It is very soluble in alcohol, whilst it dissolves fatty bodies, oils, and resins freely. Phosphorus, iodine, and sulphur are also soluble in it. Metallic salts are generally less soluble in ether than in alcohol. It dissolves corrosive sublimate freely.

Nitrous ether ($C_2 H_5 NO_2$) (sweet spirit of nitre) is made by distilling alcohol and sulphuric acid in the presence of nitric acid and copper. The copper serves to reduce the nitric to the nitrous radical.

Symptoms.

When the vapour of ether is inhaled in sufficient quantity, complete anæsthesia results, the patient passing through the stage of exhilaration.

The inhalation of a given quantity of the vapour of ether produces far more severe results than when a similar quantity is swallowed. The symptoms of inhalation may be described under three stages—

1st. The face becomes flushed, and there is considerable excitement, with hastened circulation and respiration.

2nd. Stupor succeeds; the breathing becomes laboured, the lips turn blue, there is general lividity of the surface of the body, and the pupils are widely dilated.

At this stage the patient can be easily revived.

3rd. If the administration be continued, perfect anæsthesia results, accompanied at times with extreme excitement. If the administration be prolonged after this, it causes death.

The effects produced by ether in the liquid form require further investigation. There are no cases on record of poisoning by it in the human subject. Orfila found that half an ounce introduced and secured in the stomach of a dog produced insensibility in sixteen minutes, and death after three hours. The action of all the ethers is undoubtedly far more energetic than that of the alcohols. Christison relates a case of death from the vapour, the air of a room becoming loaded during the night by the breaking of a three-gallon jar full of ether. The countenance at the post-mortem appeared composed, the lining membrane of the stomach red, and the lungs gorged. So far as our knowledge of the symptoms extends, they are very similar to those of alcohol, but more severe, although more transient. It would seem also that persons can very easily become habituated to its use.

The remarks on treatment in alcohol poisoning (p. 499) equally apply here. Fresh air, cold douche, artificial respiration and galvanism must be used without delay.

Tests.

1. Its odour:—
2. Its inflammability (the products being H_2O and CO_2).
3. Its almost perfect insolubility in water, and upon which it floats.

In a medico-legal investigation the contents of the stomach must be distilled as directed in alcohol poisoning (p. 500). Of course if any delay occurs in the examination, there will be but little hopes of a successful analysis.

KREASOTE ($C_8 H_{10} O_2$) AND OIL OF TAR.

(Creasote. Creasol.)

Oil of tar owes its properties entirely to the kreasote that it contains. Kreasote is obtained during the destructive distillation of wood. In commerce carbolic acid is often substituted for it (*vide* p. 515), being very similar both in odour and taste. It is entirely volatile at 100° C., and, like carbolic acid, possesses great preservative and antiseptic powers. Twenty-five to forty drops injected into the jugular vein of a dog killed it in a few seconds. Thirty drops killed a rabbit in a minute. The same quantity given to a dog produced convulsions and coma, but it recovered (Dr. Cormack). Dr. Pareira ("Elements of Mat. Med.") refers to a case of two drams having been swallowed, death resulting in thirty-six hours.

In the human subject the effects are those of an irritant poison. Its peculiar odour is at all times its most characteristic property.

The administration of albumen, of oleaginous and mucilaginous drinks, with artificial respiration if necessary, constitutes the treatment to be adopted. Inflammatory symptoms must be met by usual antiphlogistic measures.

Cases of Poisoning by Oil of Tar and Kreasote.

1. Pareira's "Materia Medica," 1842, vol. iv., p. 410. ʒij.		
	Result.—Death in 36 hours.	

2.

"Lancet," 1832-33, vol. ii., p. 598. Male. ℥iv of oil of tar taken by mistake for spirits.

	Result.—Recovery; able to resume his work the next day.	

3.

"Lancet," 1833-34, vol. i., p. 902. Male: æt. 18. Two or three draughts. Quantity (?).

Symptoms.—Symptoms set in very soon.	*Result.*—Death in 24 hours.	*Post-mortem.*—Stomach, intestines, and brain natural; lungs gorged with blood of a tarry colour and odour.

BICHLORIDE OF METHYLENE ($CH_2 Cl_2$).

This was suggested by Richardson as an anæsthetic in the place of chloroform.

The liquid is heavier than water, and but very slightly soluble in it. It is not inflammable.

Insensibility is more rapidly produced, and recovery more rapidly effected, by it, than by chloroform. As a rule complete anæsthesia results after about two minutes' application, and recovery in about three. Mr. Morgan ("Lancet," May 11, 1872, p. 671) states that he has never lost a case, although he has administered it about 1800 times.

Cases of Poisoning with the Vapour of Bichloride of Methylene.

1.

"Pharmaceutical Journal," 1871, p. 875. Male: æt. 40. Given during an operation on the eye.

	Result.—Death in 5 minutes.	*Post-mortem.*—Congestion of lungs.

2.

"Pharmaceutical Journal," 1871, p. 875. Male. Inhaled ʒiss.

	Result.—Death rapid.	*Post-mortem.*—No special post-mortem appearances.

3.

"Lancet," Oct. 23, 1869, p. 582 (Mr. Marshall). Male: æt. 39. ʒjss. The man was sitting in a chair during the time of administration, and preparing for an operation.

Symptoms.—Pupils slightly dilated; no stertor or lividity of countenance.	*Result.*—Death.	

COAL NAPHTHA.

Naphtha is one of the products of the distillation of coal. It acts as a narcotic poison. It is insoluble in water, and floats upon it. It burns with a smoky flame. Three ounces have proved fatal in three hours, and more than once the vapour has acted injuriously.

It produces first of all intoxication and delirium, followed by an intense coma. Stertorous breathing, a cold clammy skin, vomiting, a glassy state of the eyes, and contracted pupils, with loss of muscular power, are symptoms that are recorded. We may notice here that death has resulted from drinking a wine-glassful of *petroleum*, and that severe symptoms have been produced from the ingestion of one pint of *paraffin oil.*

Cases of Poisoning with Coal Naphtha, Petroleum, and Paraffin.

<table>
<tr><td colspan="3">1.
"Lancet," Aug. 23, 1856, p. 230. Male: æt. 12. ℥iij taken by mistake for beer.</td></tr>
<tr><td><i>Symptoms.</i>—Intoxication with delirium; afterwards collapse; stertorous breathing; cold clammy skin; vomiting, by which about 1 oz. was ejected. For 2 hours he appeared better, but collapse, insensibility, frothing at mouth, came on; eyes became glassy and fixed, pupils contracted, loss of muscular power; no convulsions; could not swallow. Death.</td><td><i>Result.</i>—Death in 3 hours.</td><td><i>Post-mortem.</i>—The smell of the naphtha was noticed at the post-mortem on the fourth day; blood fluid; right side of the heart full, and the left side empty; lungs pale; stomach not inflamed; naphtha was found in the contents of the stomach.</td></tr>
<tr><td colspan="3">2.
"Medical Times and Gazette," July 20, 1861, p. 71. Male: æt. 4. A drink.</td></tr>
<tr><td><i>Symptoms.</i>—Sleepiness, passing on to coma; vomiting, and contracted pupils; seemed to be "in articulo mortis," but afterwards recovered.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">3.
"Medical Times and Gazette," Sep. 24, 1864, p. 316.</td></tr>
<tr><td></td><td><i>Result.</i>—Death.</td><td></td></tr>
<tr><td colspan="3">4.
"British Medical Journal," Nov. 4, 1871, p. 525. Female: æt. 40. A glass of petroleum.</td></tr>
<tr><td><i>Symptoms.</i>—No nausea or vomiting; great pain in the stomach. Death on the 20th day.</td><td><i>Result.</i>—Death.</td><td></td></tr>
<tr><td colspan="3">5.
"Edinburgh Medical Journal," Nov. 1874, p. 435 (Dr. Gilruth). Female: adult. One pint of paraffin oil.</td></tr>
<tr><td><i>Symptoms.</i>—Burning sensation in stomach and throat; body cold; recovered in 24 hours. (Emetics given.)</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
</table>

NITRO-GLYCERINE ($C_3 H_5 (NO_2)_3 O_3$).

(Glonoine—Blasting Oil—Dynamite.)

Nitro-glycerine is an oily, heavy liquid, soluble in water to the extent of about 0·25 per cent., and exploding violently when struck. It is largely used in mining operations, under the name of "blasting oil," and "dynamite." The vapour, which is far more powerful in its effects than the liquid, acts, according to the best observers, as a true narcotic. When swallowed in a liquid form, as it has been several times in Sweden, narcotism was also the chief symptom induced; but it would seem from these cases that a very considerable quantity is necessary to prove fatal. Delirium, nausea, vomiting, and paralysis are also recorded symptoms, whilst congestion of the brain seems the special post-mortem appearance.

Administered to frogs by the mouth, or applied even to the unbroken skin, it causes tetanic convulsions, then paralysis and death.

Administered to cats nitro-glycerine produces very similar effects to those of hydrocyanic acid.

Demme describes some experiments made upon himself, and upon patients in the hospital at Berne, with a solution consisting of one-ninth part by weight of nitro-glycerine in rectified spirit. He considers it as energetic a poison as strychnia. Ten drops of this solution (1·1 grain) produced a smarting pain in the throat, excessive headache and vertigo, contractions of the masseters and temporal muscles (slight trismus), and twitchings of certain groups of the muscles of the limbs. The effects passed away after about twenty minutes. Therapeutically he found the drug of marked efficacy in those forms of partial paralysis in which strychnia is usually prescribed. ("Schweitz Zeitschrift," vol. i., p. 156; "Schmidt's Jahrb.," vol. cxvi., p. 174; "New Sydenham Society's Year Book," 1862, pp. 176 and 465; and 1864, p. 405; "Deutche Klinik," 1864, p. 405.)

To recover the poison from organic mixtures, they must be shaken up with chloroform, ether, or benzol, and the residue, after the recovery of the ether, or other solvent, tried on a frog.

Cases of Poisoning with Nitro-Glycerine.

1. "Sydenham Society: Biennial Retrospect," 1867-68, p. 452. Male. Some gunpowder with a few drops (?) of nitro-glycerine.		
Symptoms.—Nausea and vomiting; headache; dizziness; unconsciousness; paralysis set in after some time.	*Result.*—Recovery.	
2. "Sydenham Society: Biennial Retrospect," 1867-68, p. 453. Female: æt. 13. Drank some nitro-glycerine from a flask.		
	Result.—Death.	
3. "Sydenham Society: Biennial Retrospect," 1867-68, p. 453. Male: adult. A drink.		
Symptoms.—Became blue in the face, and insensible after 1 hour. Delirium.	*Result.*—Death in 6 hours.	*Post-mortem.*—Brain congested, lungs œdematous.
4. "Sydenham Society: Biennial Retrospect," 1867-68, p. 453. Male: adult. Quantity (?).		
	Result.—Death in 2 hours.	
See a Case of Poisoning recorded in the "Lancet," Aug. 4, 1866, p. 124. (Death in a few hours; instant pain; body dark blue.)		

TURPENTINE ($C_{10} H_{16}$).

(Turps: Terebenthene: Spirit of Turpentine: Oil of Turpentine.)

Sp. gr. 0·86. Boils at 160° C.

Turpentine is an oleo-resin, flowing from incisions made in the wood of most coniferous trees. When distilled the essential oil of turpentine, or turpentine, as it is often called, passes over, "rosin" remaining in the still. When purified by distillation with lime, in order to saturate resinous acids, this essential oil is sold under the name of *camphine.*

Turpentine dissolves sulphur, phosphorus, caoutchouc, and fatty matters. It is soluble in alcohol and ether, but is insoluble in water.

Mixed with litharge, it rapidly absorbs oxygen. It is readily oxidized by nitric acid, oxalic and terebic acids, &c., being formed.

Turpentine acts as a narcotico-acrid poison. Great irritation of the urinary organs, intoxication, contracted pupils, stertorous breathing, coma, collapse, and tetanic convulsions have been stated to have been caused by it. A criminal case of poisoning is on record, where it was urged in defence that it was given for a cough. (Reg. *v.* Rodanbosh, C.C.C. Dec., 1856.) In medicine it is often prescribed for hæmorrhages, puerperal peritonitis, and for worms, and is also used as an injection. Thus 1, 2, and 3 ozs. have been administered; but some caution is needed, inasmuch as 2 drams has been found to kill a dog in three minutes with tetanus (Scubarth), and half an ounce has proved fatal to a child.

The urine acquires a violet-like smell when turpentine has been taken internally.

Cases of Poisoning with Turpentine.

<table>
<tr><td colspan="3">1.
“Medical Times and Gazette,” Oct. 11, 1851, p. 380 (Mr. Johnson). Female: æt. 1½. A tablespoonful.</td></tr>
<tr><td><i>Symptoms.</i>—Pain soon came on, but she was afterwards soothed to sleep; after some time vomiting and convulsions set in. In 3 hours she became insensible; breathing stertorous; pupils very contracted; convulsive paroxysms, with opisthotonos, every 10 to 15 minutes.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
<tr><td colspan="3">2.
Taylor's “Medical Jurisprudence,” vol. i., p. 333 (Mr. Miall). Æt. 14 weeks. ℥ss.</td></tr>
<tr><td><i>Symptoms.</i>—Insensibility and slight convulsions, in 1 hour; pupils contracted; irregular and slow breathing (3 per minute); pupils contracted; pulse almost imperceptible.</td><td><i>Result.</i>—Death in 15 hours.</td><td></td></tr>
<tr><td colspan="3">3.
“Pharmaceutical Journal,” July, 1872, p. 75. Æt. 5 months. A spoonful given by mistake for peppermint.</td></tr>
<tr><td></td><td><i>Result.</i>—Death.</td><td></td></tr>
<tr><td colspan="3">4.
Horn's “Vierteljahrsschrift,” 1866, vol. ii., p. 337 (Dr. Thomson). Female: 22. Large quantity of camphine.</td></tr>
<tr><td><i>Symptoms.</i>—Vomiting; pain; purging came on rapidly; was never entirely unconscious; coldness and headache; pupils normal; increased quantity of urine, which smelt of violets; certain nervous symptoms occurred; recovered in 8 days.</td><td><i>Result.</i>—Recovery.</td><td></td></tr>
</table>

CHAPTER XVI.

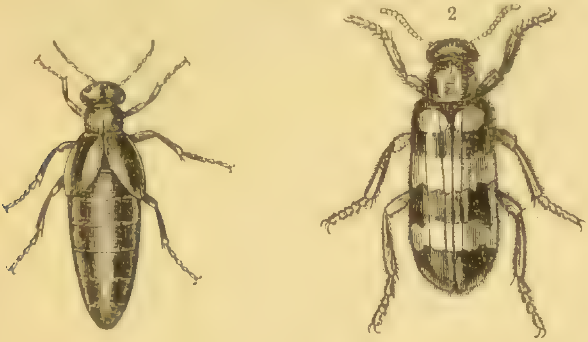
Animal Poisons.

Poisonous insects—*Cantharides*—Experiments on animals—Symptoms, &c.—Toxicological analysis—*Poisonous food*—Putrid meat—Sausage poison—Trichina—Cysticercus—Trematoda—Unwholesomeness due to the improper feeding of animals—Diseased meat—The characters of good meat—Circumstances under which meat should be condemned—Poisonous Fish.

ANIMAL IRRITANTS.

SEVERAL insects are poisonous. Death has been caused in twenty-four hours, with irritant symptoms, by the *maiworm* of the Germans (Meloe proscarabæus) (Fig. 44) ("Rust's Magazine," xviii. p. 109.) A child has died from the effects of the *bombyx*, applied externally on beet-root leaves (Christison). *Spiders* have also produced bad effects ("British Medical Journal," Aug. 8, 1863, p. 166.) Similarly, too, the poison of a *toad* ("Medical Times and Gazette," Sept. 4, 1852, p. 251), and the sting of a *wasp* on the tongue of a man, aged seventy-four, have caused death. ("Lancet," Sept. 6, 1873, p. 333.)

FIG. 43.



CANTHARIS VESICATORIA. (Fig. 44.)

(Lytta Vesicatoria).

Insecta—Coleoptera.

(Blister Beetle—Spanish Fly).

The Spanish fly is found in Russia, Sicily, and Hungary, and is an insect of about eight to ten lines in length, having fine green wing sheaths or elytra. They are collected chiefly from the ash, lilac, and privet, and are killed by being plunged into boiling vinegar.

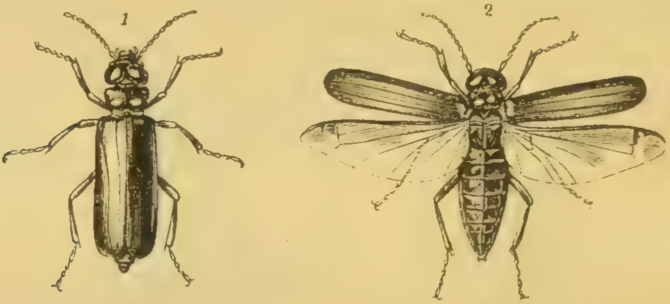
The beetles have a burning taste, and a nauseous, disagreeable smell.

The powder has a greyish green appearance, and appears loaded with shining and brilliantly metallic particles.

Cantharides is an active and irritant poison. It has been administered by way of joke, and taken for the purpose of suicide. It has been given and taken with the idea of procuring *abortion*, but in this it more often fails than succeeds, and if successful the action is due to the violent constitutional disturbance induced, rather than to any specific effects of the drug. It has been given frequently for lascivious purposes. No doubt can exist that it is capable of inducing venereal desires, but there is great doubt whether they can be excited by a dose much under that which may prove hazardous to life. And here may be noticed a matter referred to by Taylor (Reg. *v.* Wilkins: Liverpool, 1861), where a man was convicted of the administration of cantharides with the intent to excite the sexual passion, the punishment for which crime is not provided for by the law.

Nor must it be overlooked that cantharides may prove injurious by its mere external application, especially in debilitated states of the system, such as typhoid, where the inflammation produced by blisters has more than once passed on to fatal sloughing, or set up active symptoms of poisoning. Cantharides should never be used externally or internally when there is any disease of the kidneys, or in the very young or very old, or in debilitated systems.

FIG. 44.



Cantharides contains several peculiar oily and fatty matters, but its special action is due to *cantharadin.*

CANTHARIDIN ($C_5\ H_6\ O_2$?)

Cantharidin is a neutral body, and is probably the active blistering principle of other insects besides the Spanish fly. The average proportion of cantharidin present in the fly is about 4 to 5 parts in a 1000, or in other words, half an ounce of the powder yields about 1 grain of cantharidin. It crystallizes in colourless plates, has powerful vesicating properties, and sublimes without apparent decomposition at 100° C. (212° F.), leaving no residue. In this respect it differs from vegetable alkaloids, which always, when heated, leave behind a carbonaceous mass. It is insoluble in water, but is soluble in alcohol, ether, chloroform, and oils.

Neither hot nor cold sulphuric acid has any action upon it, and in this it may likewise be distinguished from active vegetable principles. Nitric acid has also no action upon it.

Experiments with Cantharides on Animals (ORFILA).

Dose.	How administered.	Symptoms.	Result.
ʒiss of an oleaginous solution.	Injected into jugular vein of dog.	Violent tetanus.	Death in 4 hours.
ʒiij of tincture and 8 grains of the powder.	Injected into stomach, and secured by ligature.	Insensibility.	Death in 24 hours.
40 grains of powder.	Given by the mouth.	Vomiting.	Death in 4½ hours.
ʒj of powder.	Placed in a wound.	Great languor.	Death in 32 hours.

These experiments upon animals scarcely agree with the symptoms observed in the human subject.

Symptoms, Dose, &c.

With the tincture the symptoms are usually rapid in their appearance, but with the powder they are somewhat slow.

The mouth, throat, and gullet soon become hot, constricted, and irritable. The patient can neither speak nor swallow, but at the same time seems dying of thirst. Salivation has been recorded. The heat of the mouth and throat is usually less severe after the powder than the tincture. Intense griping pain, increased on pressure, first in the stomach, but gradually extending over the whole abdomen ; vomiting of blood, or of bloody mucus, or of membranous flakes, or of actual portions of the membranes of the gullet, mixed, if the powder has been taken, with shining particles, will be noticed. There is usually violent straining at stool, a few drops of blood being all that is passed. A dull pain in the loins, with strangury, an incessant and uncontrollable desire to pass water, with either an absolute inability to do so, or, at most, the passage of a few drops of bloody urine, are characteristic symptoms. The genital system is usually much affected. So great may be the inflammation in these parts, that it may proceed even to gangrene. Priapism is usually severe, and no doubt large doses may give rise to aphrodisiac propensities. The breathing is laborious and painful, the pulse quick and hard, and before death it is not unlikely that a train of nervous symptoms may set in—such as headache, coma, tetanic spasms, and convulsions. A seeming convalescence is not to be trusted, as a relapse, even after some days, has been more than once recorded. Recovery is usually very slow ; the trouble in swallowing, the pains in the kidneys, and the difficult micturition being persistent symptoms.

These symptoms, important and well marked as they usually are, must not be regarded as absolutely infallible tests, inasmuch as people have been charged more than once with administering cantharides from the existence of certain symptoms, such as inflammation of the genital organs, when there was no evidence in support of the charge, and the poison itself could not be found by analysis. As we have already said, the discovery of a poison is at all times the only certain evidence of its administration. And here, in cantharides poisoning, it is particularly necessary to reiterate it.

The action of cantharides is much influenced by idiosyncracy. A case is recorded where a boy, by merely smelling the tincture, had erection and involuntary emissions (Christison), whilst, on the other hand, 8 ounces of the tincture is reported to have been taken without injury. But, in addition to idiosyncracy, the varying symptoms produced are often to be accounted for by the variable amounts of cantharidin present in different samples of the fly.

What may be regarded as a medicinal dose? Thomson says, 1 to 3 grains of the powder; *Pareira*, 1 to 2 grains of the powder, and 10m. increased to ʒj of the tincture; *Garrod*, 5 to 30 min. of the tincture, whilst the late *Dr. Dyce* stated that he was in the habit of giving 10 grains of the powder as a medicinal dose.

Of the doses that have caused death, 24 grs. taken in 2 doses killed in four days, and 1 oz. of the tincture (= about 6 grs. of the powder) in seventeen. The use of cantharides ointment has proved fatal ("Lancet," Feb. 13, 1841, p. 733).

On the other hand, recovery is recorded after 1 oz. and 6 ozs. of the tincture, and after 1 dram of the powder.

The action of cantharides is not rapid, twenty-four hours being the shortest period on record in which it has caused death, whilst cases are recorded of death after four, and even seventeen days. Frequently a period of convalescence takes place after the active symptoms have passed away, and before the fatal result.

Treatment.

In every way promote vomiting by administering emetics and thick warm liquids. It is doubtful whether oil should be administered, as cantharidin is soluble in it. Opiate injections into the bladder and rectum, and opium suppositories should be used to relieve pain, whilst if there is much inflammatory action, leeches should be applied. A warm bath is often very comforting.

Post-Mortem Appearances.

The mouth and throat are usually found stripped of their mucous membrane, whilst intense inflammation is commonly noticed throughout the whole of the alimentary, urinary, and genital tracts. The stomach and the genital organs may even be found gangrenous. The brain, lungs, liver, and spleen, but more especially the kidneys, are invariably gorged with blood.

Toxicological Analysis.

In conducting a medico-legal examination, look carefully, first of all, for particles of the insect. It has been advised to blow the intestines out, and after allowing them to dry, to search in the dried gut for shining particles. We regard it ourselves as preferable, first of all, thoroughly to wash the intestines out, to allow the sediment to collect, to syphon off the clear liquid, and then to search for particles in the sediment. It is stated that such particles are most likely to be found in the great intestines, and least likely to be found in the stomach. They certainly have a wonderful power of resisting putrefaction, so much so that they may be discovered months after death.

Any particles that are found must be collected, acted upon with ether, or chloroform, the solvent poured off, and evaporated down, and the extract so obtained applied to the ear of a rabbit to see whether it is capable of producing a blister. When a blister is formed, the rabbit should be killed, and the ear produced in court as evidence.

If the tincture has been given, of course no particles will be found. The contents of the stomach should then be evaporated to a thick extract. This must be acted upon with alcohol acidulated with acetic acid, evaporated to a thick syrup, and shaken up either with chloroform or with ether, the former being a better solvent for cantharidin than the latter. Decant the solvent, and allow it to evaporate spontaneously, and test the residue as to its vesicant properties either on one's own skin, or preferably on the ear of a rabbit.

Cases of Poisoning with Cantharides.

1. "Medical Times," Feb. 3, 1849, p. 287 (Mr. Saunders). ℥ss of powder.		
	Result.—Death in 24 hours.	*Post-mortem.*—Vessels of brain full of dark-coloured blood; lungs engorged; gullet, stomach, and intestines much inflamed, portions of the mucous coat of stomach being detached; cantharides powder found in small intestines; liver engorged; gall-bladder full of bile; spleen and kidneys congested; ureters inflamed; bladder empty and contracted, internal surface being pale.
2. Orfila's "Toxicologie," vol. ii., p. 30, from "Gazette de Santé," May, 1819. Female. Twenty-four grains of powder taken in 2 doses, at an interval of 1 day.		
Symptoms.—Abortion; mind clear to the last; dilated pupils; convulsions; ordinary symptoms occurred.	*Result.*—Death in 4 days.	*Post-mortem.*—Brain gorged with blood; omentum, peritoneum, gullet, stomach, intestines, kidneys, ureters, and the internal parts of generation inflamed; mouth and tongue stripped of their lining membrane.
3. Orfila's "Toxicologie," vol. ii., p. 28 (Mr. Biett). Male. ʒj of powder.		
Symptoms.—Burning in throat and stomach; in 1 hour violent pain set in in the bowels; great thirst, but could not swallow without violent pain; voice feeble; breathing laborious; tenesmus and strangury; a few drops of blood were passed both by the bowels and urethra; for some days suffered from priapism, difficult micturition and heat of alimentary canal; for some months there was difficulty of swallowing.	*Result.*—Recovery.	
4. "Edinburgh Medical and Surgical Journal," vol. xxxiv., p. 214 (M. Rouquayrol). Dose (?).		
Symptoms.—Ordinary symptoms; salivation; on the second day a cylindrical mass, apparently the inner membrane of the gullet, was discharged by vomiting.	*Result.*—Recovery.	

5.

"Christison," p. 613 (Dr. Osborne). Female. ? probably powder.

Symptoms.—The usual symptoms of irritation of the bladder and bowels lasted for 36 hours; for 3 days after this she appeared convalescent, but on the 5th day the urinary symptoms returned, with prostration, feeble pulse, and diarrhœa.	*Result.*—Recovery.	

6.

"Lancet," Aug. 17, 1872, p. 247 (Dr. Pallé).

Symptoms.—A number of soldiers drank the tincture; no cerebral symptoms occurred; great pain in bladder and bowels; no priapism, nor aprodisia; urine albuminous in every case; some of the men had paraplegia. All recovered. (Emetics, warm-baths, camphor and opium administered.)	*Result.*—Recovery.	

7.

"Medical Times and Gazette," Dec. 10, 1864, p. 617 (Mr. Sedgwick). Female: æt. 13.
A Spanish fly put into a jam tart.

Symptoms.—In half-an-hour giddiness came on, and shortly afterwards insensibilty; the following day the stomach and vulvæ became swollen and irritable; there was great bearing-down pain; bloody vomiting; scanty urine; on the second day strangury set in, and she complained of a disagreeable smell in the nostrils; on the 19th day epileptic fits occurred and hysterical symptoms; menstruation ceased; after 7 months time the fits disappeared, and she again became regular.	*Result.*—Recovery.	

8.

"Medical Times," Oct. 2, 1841, p. 9 and 41 (Dr. Cheesman). Female. ℥j of the tincture.

Symptoms.—Apparent intoxication; great pain; abdomen became very swollen; pulse scarcely perceptible; delirium came on in 24 hours; urine had to be drawn off.	*Result.*—Recovery in 14 days.	

9.

"Medical Gazette," 1841, vol. i., p. 63. Female. ℥j of tincture.

Symptoms.—Appeared intoxicated during the day; next day there was great pain in the bowels; anxious countenance, and dry tongue; in the evening there was retention of urine, weak pulse, and coldness of extremities; delirium came on at night. She recovered by degrees. but was troubled with retention of urine and pains in the kidneys for some time.	*Result.*—Recovery.	

10.

Taylor's "Medical Jurisprudence," vol. i., p. 337; "Christison," p. 614. Male: æt. 17.
℥j of tincture.

Symptoms.—Ordinary symptoms occurred; after the second day he appeared convalescent for 14 days, when shiverings, convulsions, and coma came on, from which he died on the 17th day.	*Result.*—Died in 17 days.	*Post-mortem.*—Brain gorged; stomach softened; kidneys much inflamed and congested.

11. Pareira's "Materia Medica," vol. ii., p. 750. Male. ʒvj of tincture.		
Symptoms.—No dangerous symptoms.	*Result.*—Recovery.	

12. "Lancet," Feb. 13, 1841, p. 733 (Mr. Snow). Female: æt. 60. Swallowed a piece of blistering plaster, the size of a walnut.		
Symptoms.—Symptoms set in after an hour; vomiting, strangury, &c., and these lasted for a few days.	*Result.*—Recovery.	

See also the following Cases of Poisoning by Cantharides:—

"Medical Times and Gazette," March 6, 1852, p. 255. (Suspected case.)
"Medical Times," April 17, 1847, p. 166.
,, ,, March 1, 1845, p. 463.
"British Medical Journal," Oct. 28, 1871, p. 497.
"Edinburgh Medical and Surgical Journal," Oct. 1841. (Recovery after 20 grains.)
"Medical Gazette," vol. xlii, p. 873. (Recovery after ʒij of the tincture.)

POISONOUS FOODS (Meat, Milk, Cheese, Honey, &c.).

Under certain circumstances, meat becomes poisonous. Sometimes, as in the case of pork, no cause for this can be discovered, and we are compelled to assign it to some peculiar idiosyncracy in the person who has partaken of it; whilst at other times, it may as certainly be traced to definite changes in the meat itself. Some of these we must consider.

I. *Unwholesomeness in meat due to putridity.* The symptoms induced are often those of an irritant poison. Vomiting and purging are at once both the symptoms and the cure. Severe results, as unfortunately is too well known, are often produced by the putrid inoculations of the dissecting room, whilst the action of morbid fluids in producing poisonous effects by mere contact with the skin, no wound or abrasion being apparent, is also recorded ("Lancet," Oct. 14, 1871, p. 537). But we are not speaking now so much of this form of poisoning as of that produced by the ingestion of putrid meat. And there are several cases of this kind recorded. The putrid flesh of horses has produced gangrene and scurvy (Foderé). Thirty-two persons died on one occasion after having eaten the putrid brain of a walrus (Czant's "Greenland"). Dr. Taylor tells of the evil effects arising from a putrid hare. The meat of a calf that died of distemper produced severe symptoms ("British Medical Journal," July 7, 1866, p. 31). Musty bacon ("Lancet," March 14th, 1846, p. 302, and "Medical Times," March 7, 1845, p. 455), decaying mutton (Ollivier), and mouldy veal (Zurich, 1839), have also at different times caused bad symptoms of poisoning.

And here it may be well to consider the evil effects produced by meat in a state, not of *complete* but of *modified putrefaction*, as in the case of the well-known Wurtemburg sausage poison. Dr. Letheby has given an account of an outbreak of disease in London (fortunately only one case proving fatal) caused by sausages ("Brit. and For. Med Review," Jan., 1860). It has been stated (and it is remarkable if it be true) that the poisonous effects are not developed by the Wurtemburg sausages when they have been allowed to undergo *complete* putrefaction. Hence we are led to believe that the active body, whatever it may be, developed by *partial* decomposition, is destroyed when that decomposition is perfect. The nature of this sausage poison has been a subject of much discussion.

(*a*) Some hold that the poisonous action is due to certain rancid, fatty acids, formed during decay.

(β) Others consider it due to the development of certain pyrogenous acids, formed during the process of drying and smoking.

(γ) Others consider it due to the production of a poisonous organic alkaloid.

(δ) Others (as Liebig) believe that what is called a catalytic body is produced, which is capable of setting up in other bodies a similar catalytic action to its own.

(ε) But the most probable theory (that of M. Vanden Corput and others) is, that the poisonous action is due to the presence of a minute fungus (Sarcina botulina). This view is borne out, not merely by the fact that a well-marked mouldiness has been noticed in the sausages, but likewise that they have been found to be peculiarly liable to act injuriously about April, when such cryptogamic organisms are specially developed.

The symptoms rarely commence in less than twenty-four hours, and often after a still longer period, terminating between the third and eighth day with convulsions, or if the case gets well by a very prolonged convalescence.

Cases of severe symptoms from eating pork brawn have also occurred, vomiting, purging, and cramps being the symptoms recorded ("British Medical Journal," May 10, 1873, p. 533, and May 17, 1873, p. 559). Also from eating potted meats, in which no poison could be detected, but which were evidently at the time undergoing incipient putrefaction ("Medical Times and Gazette," Aug. 5, 1854, p. 152).

A rabbit pie is said to have caused serious symptoms. The poisonous effects were produced, it is believed, by its having been kept too long after baking ("Lancet," Sept. 13, 1862, p. 297).

II. *Trichina.* This is the ova of the Trichina spiralis (θρίξ, a hair), a thread-like worm, varying in length from the $\frac{1}{8}$th to the $\frac{1}{50}$th of an inch. It may make a home in the flesh of any animal, but it is found most frequently in the pig. Of all parts its most favourite seat is said to be the muscles of the eye. Hence the German sausage-makers profess to have these muscles specially examined by an expert before using the meat of an animal. Trichinous pork is generally *dark coloured* from the creature setting up inflammatory action, and *speckled* from the cysts, which are small white bodies, being just visible to the naked eye. 6000 trichina, each containing from 60 to 80 embryos, have been said to be found in 1 gramme of pork (Dr. Pietra Santa).

But although its presence is special to no one animal, its terrible effects are believed to be peculiar to man. The history of the trichina is curious. Chrysalis-like, it hides itself in the muscle of some animal, seeming to do little or no harm. It lives a life of inactivity. Another animal, however, eats the trichinous meat. The ova now find a warm and suitable soil in the stomach for their development. The gastric juice digests the sacs, and in about six or eight days their development is complete, whilst in three or four more each female will give life to over 100 young ones. The worms being now set loose and free to work their mission, force their way through intestine and stomach, into any and every muscle of the body, until at last their progress is stopped, and they are again enveloped in cysts, ready to be set free and to propagate themselves in the next stomach into which they may find entrance.

In the human subject, however, the trichina finds a peculiarly congenial soil, the terrible symptoms produced by it in man not occurring, as we have said, in other animals. In a few days after eating the parasitic meat, symptoms of irritant poisoning set in; the digestive functions are interfered with; lassitude, loss of appetite, sickness, pains in the muscles, and especially in those of the back and head, vomiting and diarrhœa, and swelling of the joints will be more or less complained of. In seven or eight days' time intense fever will be set up, whilst the journeyings of the worms in making their way along muscles will give rise to excruciating pains and even paralysis from the destruction of the muscular fibres. Probably from this time the case will progress rapidly towards a fatal termination, death resulting either by coma or from the setting in of severe pneumonia. Nature, however, may once more imprison the animals and barricade them in cysts, and thus the patient partially or wholly recover.

As regards post-mortem appearances, the muscles here and there will be found speckled—that is, light spots will be seen on a reddish ground. Treatment, there is none.

Possibly trichinous meat may have been the cause of some of those mysterious cases occurring in the practice of every toxicologist, where we find all the symptoms of death by an irritant, although no poison can be found on analysis. In such cases it might be advisable to examine the muscles, especially the muscles of the eye and trunk, for trichina.

Cases are occasionally met with in which, although the muscles are full of trichinæ, no symptoms are complained of in life.

Note that as the results of trichina, however, (1) a considerable interval generally elapses between taking the food and the poisonous effects; (2) that the vomiting and purging are not severe; (3) that the intense pain is in the muscles, as well as in the stomach and bowels; (4) that pneumonia is almost a constant symptom, and (5) that no poison will be discovered on analysis.

The trichina are not destroyed by salt, or by smoke, or indeed by putrefaction. They are destroyed, however, by thorough cooking, and for this reason all meat for the table should be well done.

The following are a few recorded Cases of outbreaks of Trichinous Disease.

"Annales d'Hygiéne," Oct., 1863, p. 471. Outbreak at Planen—from eating pork, to which 30 cases of illness were traced—only one died.

"British Medical Journal," Jan. 16, 1864, p. 75. Outbreak at Hettstädt. One hundred and three persons affected with trichinous disease from eating fried sausages. Eighty-three persons died.

"Annales d'Hygiène," April 1, 1864, p. 321. Twenty persons partook of some pork at a wedding. Two died. Trichina found.

"British Medical Journal," May 27, 1865, p. 543. Several persons attacked after eating an uncooked smoked trichinous ham. Four died.

"Lancet," 1871, vol. i., pp. 515 and 710. Outbreak at Massachusetts. One died. Six persons attacked.

III. The *cysticercus* has been found in all animals, those of beef and veal being smaller than those of pork. The cysticerci are the larvæ of tapeworms. Microscopically they consist of little sacs, embedded in the muscles, containing minute animals, having bladder-like tails, disappearing when cooked, with a crown of hooks at the head. They are to be found in the muscular tissue of every part of the body, and, as we have said, of all animals, but in the pig *par excellence* (*measly pork*).

The history of the cysticercus is as follows :—

When swallowed by a human being (for it is in the *human* intestines it becomes fully developed) the sac is digested and the animal set free. It then fixes itself to the intestines by its hooks, and bit by bit grows into a tapeworm. Myriads of ova creature each segment of the worms, and these, passed by the bowels, find their way into the sewage. If this be placed on the land, as some, with their vehement love for irrigation desire, the ova, along with the food grown on such land, find a home in a fresh supply of animals, to generate a fresh stock of tapeworms when the animals are eaten as food.

The pork cysticercus becomes the *Tenia solium*, and the beef and veal cysticercus the *Tenia mediocanellata.* It has been shown, too, that the Tenia echinococcus of the dog develops itself into the hydatid of man. This is the history of an hydatid. A piece of diseased offal is thrown to a dog. The dog passes by the bowels, either on the field or in the stream, segments of the developed worm. Cattle and sheep swallow these segments. At last, the animal that has swallowed them becomes the food of man, and then the larval tapeworm becomes a bladder-like hydatid. In the ox, it goes to the peritoneal cavity ; in the sheep, to the brain, producing "staggers ;" and in the man, to the liver.

Good cooking is our only safeguard, for the activity of the echinococcus is destroyed by a sufficiency of heat. Raw meat should never be eaten.

The echinococcus disease is alarmingly common in Iceland. It is asserted that one out of every five deaths is due to it (Dr. Leared). Certain facts are worth noting. It very rarely attacks the lungs in man, whilst it very commonly does so, either primarily or secondarily, in animals. Jaundice is a rare symptom, being present only in seven out of 166 cases. Women are more frequently affected than men in the proportion of 2·4 to 1. The disease is commonest in people from twenty to thirty years of age ("Lancet," Jan. 16, 1869).

IV. *Flukes*, or *Trematoda*, form another class of parasitic animals, rendering food unwholesome. They especially infest the livers and intestines of men and of herbivorous animals (Liver-fluke).

"The way in which the fluke disease is produced in sheep is curious. Ova are passed from the gall bladder of infected animals into the intestines, and are voided with the excrement upon the land ; finding a moist situation, they are soon hatched into ciliated circular embryos, which swim or move about, and ere long become attached to some mollusc, as a small snail or slug, when they change their condition, and acquire the form of a small bladder-like hydatid, called a cercaria-sac, which soon gives origin to a multitude of young tailed cercaria. These undergo a variety of transformations, and, at last, under favourable circumstances, become pupas, which are buried in the body of the snail. In wet weather the infected snails crawl upon the grass, and are eaten by the sheep, and then the pupa speedily changes its condition and becomes a perfect fluke. When it is found in the body of man it has, perhaps, been drunk with water, or eaten with some aquatic plant, as watercress, &c." (Letheby).

V. It has been remarked more than once that meat sometimes becomes unwholesome from an animal having been excited before death by over-driving, or by torture. This, however, can scarcely be determined by an inspection of the carcase, nor would it be allowable to condemn it for such a cause. Hares killed by coursing are said often to undergo very rapid changes after death, severe symptoms having been produced when they have been eaten ("Lancet," Sept. 27, 1862, p. 347).

VI. Occasionally the food eaten by animals has been a cause of their flesh proving unwholesome. *Hares* fed on the Rhododendron chrysanthemum, *pheasants* on the laurel, and the flesh of various other animals fed on the lotus, the wild melon, and the wild cucumber in Australia, have caused, when partaken of as food, severe symptoms of a poisonous nature. Other illustrations of a similar kind are recorded. The *milk of goats* has produced dangerous effects; in one case from the goats having fed on wild herbs ("Medical Times and Gazette," Nov. 1, 1856, p. 456); in a second, from their having fed on spurgeworts (Euphorbiaceæ) ("Medical Times and Gazette," June 31, 1863, p. 113), and in a third (and in this case a death is reported to have resulted) from their having fed on the Æthusa cynapium ("British Medical Journal," Sept. 6, 1873, p. 295). The history again of *the Trebizond honey* is another case in point, the plant from which the honey was gathered being the undoubted cause of its poisonous and intoxicating properties. *Snails* have proved poisonous, owing to their feed. For this reason it is customary after they have been collected to submit them to a few days' fasting, before serving them up to table ("Lancet," Sept. 6, 1873, p. 340).

Sale of Diseased Meat.

In our courts of law the sale of diseased meat is not uncommonly a matter of trial. The scientific witness is invariably met with the question—What are the effects of such meat on the human system? He must be prepared to admit that no doubt diseased meat has often been eaten, and no harm resulted. Two causes may be assigned for this. (1) That the stomach has a peculiar protective power of its own, evidenced by the fact that even the poison of the rattle-snake has been swallowed without injury, and (2) that the meat may possibly have been rendered more or less safe by cooking. He must be prepared to admit that *braxy mutton* is not unfrequently eaten by the Scotch shepherds, as well as the flesh of sheep that have died from "staggers." But these are surely not to be regarded as arguments to prove that diseased meat may be safely sold in our public markets. For although such meat may prove harmless at one time, terrible results are sometimes produced. "I have often had," says Dr. Letheby, "to investigate cases of mysterious disease, which had undoubtedly been caused by unsound meat. One of these of more than ordinary interest occurred in the month of November, 1860. The history of it is this:—A forequarter of cow beef was purchased in Newgate market by a sausage-maker, who lived at Kingsland, and who immediately converted it into sausage meat. Sixty-six persons were know to have eaten that meat, and sixty-four of them were attacked with sickness, diarrhœa, and great prostration of vital powers. One of them died; and at the request of the coroner I made a searching inquiry into the matter, from which I ascertained that the meat was diseased, and that it, and it alone, had been the cause of all the mischief."

Gamgee's experience is remarkable. He shows that at a convict establishment, of 1500 inmates, where diseased cattle, and especially cattle suffering from lung disease, are eaten in large quantities, as many as forty or fifty cases of boils or carbuncles occur per month. Dr. Livingstone tells us how the South Africans, who eat the flesh of animals dying of pleuro-pneumonia, are often affected with malignant carbuncle. Dr. Letheby draws attention to the fact that since 1842, when the pleuro-pneumonia of animals was imported into this country from Holland, the number of deaths from carbuncle has been gradually increasing. The same fact is noted by the Registrar-General for Scotland, since the lung disease in animals was introduced into that country. No doubt more accurate experiments are needed, and it has been proposed that the vendors who assert that such meat is wholesome, should be the individuals upon whom its action should be tried. *A priori* reasoning, however, must surely be sufficient to prove that diseased meat should not be sold to the public. Again, the flesh of animals at the time of, or immediately preceding or succeeding the giving birth to their young, is unwholesome, for the nourishment has been absorbed by the offspring, and the whole system is in a state of upset. If not in an actually morbid condition, certainly such meat must be in a very perverted state of natural health. It is not improbable, moreover, that some feverishness, or other bad symptoms existed, which necessitated, and was the true cause of the animal being killed. It will often in these cases be urged by counsel that the animal was killed because it could not be delivered. This, however, should not be allowed to be an excuse, because parturition, although a healthy process, is one where all the conditions of the system are for a time changed, in order to bring about by a violent action (for parturition involves pain), the separation of the fœtus from the mother, and the production of a secretion to serve for its support and maintenance.

What are the characters of good meat? They are thus summarized by Dr. Letheby:—

1. It is neither of a pale pink colour, nor of a deep purple tint; for the former is a sign of disease, and the latter indicates that the animal has not been slaughtered, but has either died with the blood in it, or suffered from acute fever.

2. It has a marbled appearance from the ramifications of little veins of fat among the muscles.

3. It should be firm and elastic to the touch, and should scarcely moisten the fingers, bad meat being wet, sodden, and flabby, and the fat looking like jelly or wet parchment.

4. It should have little or no odour, and the odour should not be disagreeable; for diseased meat has a sickly, cadaverous smell, and sometimes a smell of physic. This is very discoverable when the meat is chopped up, and drenched with warm water.

5. It should not run to water, nor become very wet on standing for a day or so, but should, on the contrary, dry upon the surface.

6. When dried at a temperature of 212° F., or thereabouts, it should not lose more than 70 to 74 per cent. of its weight; whereas bad meat will often lose as much as 80 per cent.

7. It should not shrink or waste much in cooking. Other properties of a more refined character will also serve for the recognition of bad meat, as that the juice of the flesh is alkaline or neutral to test paper, instead of being *distinctly acid*, whilst the muscular fibre, when examined under the microscope, is found sodden and ill-defined.

We may next inquire what are the circumstances under which meat should be condemned and destroyed as unfit for human food.

1. The flesh of all diseased animals should be condemned; *e.g.* those that have suffered from carbuncular disease, pleuro-pneumonia (braxy mutton), &c. &c.

2. The flesh of all animals to which immediately before death physic had been administered, this being *prima facie* proof of illness.

3. The flesh of female animals killed immediately before, during, or after parturition.

4. The flesh of fœtal and very young animals generally. The meat in these cases is sodden and unwholesome.

5. The flesh of all animals which came to their death by any means other than the butcher's knife. The possible exceptions to this rule are so few, that it is dangerous to admit any.

The evil effects produced by the milk of cows suffering from the Foot and Mouth Disease deserve mention. One of the authors has seen severe symptoms induced from this cause. Further cases are also recorded ("British Medical Journal," Dec. 25, 1875).

The occasional poisonous nature of cheese is well known. We have ourselves seen more than one case where alarming symptoms have been produced by it, although no poison was found in the cheese. The impregnation of the cheese with copper from the copper vessels used in the dairy has been suggested as the cause of the symptoms, but without reason. The formation of peculiar acids, or of rancid oils, or some special and peculiar food that the cows have eaten, have also been urged as explanations. (*Vide* "Lancet," March 1, 1873, p. 328, ten cases.)

We may further notice that a glandered horse may give the glanders to a man, and that this may prove fatal. ("British Medical Journal," Oct. 11, 1862, p. 382.) Dr. Newman, of Stamford, records a most interesting case of death from animal poisoning in a veterinary surgeon, from making a post-mortem on a horse that died from the effects of some such pyæmic condition. No symptoms were developed for a week.

Cases of Poisoning by Meat, &c.

"Medical Times and Gazette," March 5, 1864, p. 265. (Leg of pork. Twelve attacked: ages five to eighty. Nothing found on analysis (Taylor), and nothing by microscope (Kesteven).

"Medical Times and Gazette," Dec. 20, 1862, p. 669. (Croton oil given as a medicine to sheep. The pluck proved poisonous.)

"Medical Times and Gazette," Sep. 13, 1862, p. 282. (Poisoning by Canadian partridges fed on certain poisonous berries.)

"Medical Times and Gazette," Dec. 13, 1862, p. 648. (Poisoning by turtle and sardines.)

"Medical Times and Gazette," Aug. 5, 1854, p. 152. (Poisoning by potted meats; no poison found; the meats were undergoing incipient putrefaction.)

"British Medical Journal," May 17, 1873, p. 559. (Poisoning from pork brawn.)

"British Medical Journal," May 10, 1873, p. 533. (Poisoning from pork brawn. Fourteen persons rendered ill. Vomiting and purging).

"Medical Times and Gazette," Nov. 1, 1856, p. 456. (Poisoning from the milk of goats fed on wild herbs in Malta.)

"Medical Times and Gazette," June 24, 1871, p. 728. (Poisoning from mutton, the sheep having eaten wild cucumber and wild melon, Australia.)

"Lancet," Sep. 13, 1862, p. 297. (Rabbit pie produced poisonous effects from its being kept too long after baking.)

"Lancet," Sep. 27, 1862, p. 347. (Poisonous effects from hares due to the rapid change they undergo after coursing.)

"Medical Times and Gazette," March 18, 1871, p. 325. (A turkey proved poisonous. No poison found.)

"Medical Times," March 7, 1845, p. 455. (Mr. Toynbee's cases of the bad effects of bacon, eaten in a state of decomposition.)

"British Medical Journal," March 24, 1866, p. 315. (Death from unsound mutton.)

POISONOUS FISH.

This is a subject which is full of obscurity. Some fish are found at times to be poisonous that are ordinarily nutritive, such as the conger-eel, the oyster, and the mussel; some are poisonous to one person, but not poisonous to another; whilst there are other fish, especially in hot climates, that seem to be always poisonous, such as the clupea, the yellow-billed sprat, &c. As regards mussels, it is well authenticated that under certain circumstances they act as poisons, as few as ten, six, and even one, having caused dangerous symptoms. The theories in explanation have been numerous. Some have accounted for the poisonous effects by the peculiar food eaten by the fish. M. de Beunie suggests that the poison of the mussel is due to their feeding on the spawn of star-fishes, which is irritant in its action, and causes intense inflammation wherever it touches ("Journal de Pharm. et Chem.," 1871, p. 298); others suppose it due to the fish being impregnated with copper from the copper bottoms of vessels (Bouchardat); others that it is due to their having undergone a process of decay before they were eaten (Burrows); others that it is due entirely to the peculiar idiosyncracy of the person who eats them, which in some cases, but not in all, is an undoubted fact (Dr. Edwards); whilst others urge that it is due to disease in the fish. There is little doubt, however, that the poisonous action is due to some definite animal poison, of what nature we do not know, in the fish themselves (Dr. Coldstream). The symptoms may show themselves either as soon as ten or fifteen minutes, or not for twenty-four hours. Sometimes they are merely symptoms of local irritation. At other times a nettle-rash eruption, with violent irritation, preceded by coryza and itching of the eyes and eyelids occurs, succeeded (though sometimes preceded) by troublesome asthmatical symptoms. At other times a peculiar condition is noticed, consisting of great muscular debility, inability to stand, numbness of the limbs, feeble action of the heart, coma, and epileptiform convulsions. Death has occurred in three and seven hours, but, as a rule, patients recover. No marked post-mortem appearances have been found. Oysters, eels, crabs, lobsters, and mackerel have similarly from time to time given rise to dangerous symptoms.

To get rid of the poison by emetics and purgatives, and to support the patient, are the two great elements in treatment. Ether seems to be useful.

The following cases are recorded :—

1. "Orfila Toxicologie Générale," vol. ii., p. 44.
2. "Guy's Hospital Reports," Oct. 1850, p. 213. Severe symptoms from eating two mussels; scarlatenial eruption.

3. "Medical Times and Gazette," April 30, 1864, p. 496. Severe symptoms from one mussel.

4. "Lancet," May 5, 1866, p. 482. Severe symptoms, after four days, from eating five or six cooked mussels.

5. "Lancet," March 7, 1846, p. 274. Severe symptoms, including paralysis, from eating about 50 mussels.

6. "Medical Times and Gazette," Nov. 1, 1862, p. 479. A family taken ill from eating a quart of mussels. One died in three hours.

7. "Medical Times and Gazette," July 28, 1860. Twenty-one persons made ill by mussels. Three children died.

8. "Lancet," Feb. 15th, and March 1, 1873, pp. 247 and 323. Three boys died from eating mussels. An adult made ill from eating a quart.

9. Foderé, "Médecine Légale," vol. iv., p. 85. Death from mussels.

10. "Lancet," June 21, 1873, p. 875. Death 25 days after eating a conger eel.

11. "Lancet," July 30, 1864, p. 132. Death on ninth day from eating mackerel.

12. "Lancet," Oct. 27, 1866, p. 482. Three deaths from eating Norwegian crabs.

CHAPTER XVII.

Gaseous Poisons.

Carbonic acid—Sources of—Symptoms, &c.—Its poisonous action not merely negative—Quantity necessary to destroy life—Quantity ordinarily present in air—Per-centage in air necessary to extinguish a taper—Over-crowding—Rate of diffusibility—Tests—Vapours from charcoal and blast furnaces—*Carbonic Oxide*—Properties and tests—List of poisoning cases—*Coal Gas*—Symptoms, &c.—List of poisoning cases—*Nitrous Oxide*—Fumes of nitric and nitrous acids—*Phosphoretted hydrogen*—*Seleniuretted hydrogen*—*Sulphuretted hydrogen*—Symptoms, &c.—Experiments on animals—Sewer gases—Tests—*Sulphurous acid.*

CARBONIC ACID GAS ($C\,O_2 = 44$).

(Carbonic Anhydride—Carbonic Dioxide—Fixed Air—Choke Damp of Miners.)

[Sp. gr. 1·529. — Condenses to a liquid at 0°C. by a pressure of 35·4 atmospheres, and at -25°C. by 17·2 atmospheres.—Density of the liquid acid at—20°C. = 0·9 and at -30°C. = 0·6.—Temp. of solid carbonic acid = -78°C.]

Sources of Carbonic Acid.

(1) *Respiration.*—In this way persons may die asleep in a crowded room, and be supposed to have been murdered. About 14,000 grains of the acid is believed to be discharged daily by the lungs of an adult, and about 60 grains by the skin.

(2) *Fermentation.*—It is most dangerous to put the head into a vat where fermentation is going, or has been going, on. All fermenting vats should have a hole at the bottom, capable of being unstopped, in order to allow the carbonic acid to escape.

(3) *The burning of lime in kilns.*—The carbonic acid is expelled from the limestone (carbonate of lime) in immense volumes by the heat applied. People have been poisoned by sleeping near a lime kiln.

(4) *The action of subterranean heat upon limestone in volcanic districts.*—In this way large volumes of carbonic acid escape into the air from fissures in the soil, charging at the same time the springs of the district with the gas, which is given off from the water when it comes to the surface. (Examples—Springs of Seltzer, Pyrmont, Marienbad, and Tunbridge.)

5. *The oxidation of vegetable and other organic matters.*—In this way spring water may become charged with carbonic acid, viz., by the oxidation of the organic matter held in solution. A well aerated water, containing organic matter, will be found, if kept in close vessels, to contain after a time a notable increase of carbonic acid, and a corresponding decrease of oxygen. Spring water in a sandy district, where there is but little vegetation, usually contains very little carbonic acid; but, on the other hand, spring water in districts where vegetation is luxuriant,

generally contains a large quantity of carbonic acid, and a small amount of oxygen.

(6) *Explosions of fire damp.*—Carbonic acid constitutes the choke-damp (after-damp) of the miners. This is the chief cause of the fatal results of coal-mine explosions.

(7) *Carbonic acid frequently accumulates in pits, cellars, wells, and in old mines,* and is produced in these cases by the decomposition of animal and vegetable matters.

(8) Whenever carbon, or bodies containing it, such as oil, wood, coal, or tallow, are burnt either in air or oxygen, carbonic acid is formed. The cases of suicide by the French charcoal chauffers are illustrations in point. Two candles, of six to the pound, are found to produce about 38 litres of carbonic acid per hour, or, in other words, about the same amount that is produced during a similar time by an adult in the process of respiration.

Preparation and Properties.

Carbonic acid is usually prepared in the laboratory by the addition of an acid to a carbonate. It is a very weak acid, and is expelled from its compounds by almost every other acid that is freely soluble in water.

Carbonic acid is a heavy, colourless, transparent gas, having a faintly acid taste and smell. It can be liquefied at ordinary temperatures by a pressure of forty or fifty atmospheres. The liquid acid does not mix freely either with water, or with the fixed oils, but it is very soluble in alcohol, ether, naphtha, turpentine, and carbon disulphide.

When liquid carbonic acid is allowed to escape into the air, it freezes into a snow-white solid. The gas is soluble in its own bulk of water, but under pressure a much greater quantity than this may be made to dissolve.

Carbonic acid gas is not inflammable, nor will it support combustion. This property, however, of extinguishing flame is not, it must be remembered, peculiar to carbonic acid. Carbonic acid has no action on the metals. It is freely absorbed by any of the alkalies. Nearly all the carbonates, except those of the alkaline metals, are insoluble in water.

Symptoms, Dose, &c.

The symptoms of carbonic acid poisoning vary according to its dilution and its admixture with other gases.

If the gas be *pure*, it causes death instantaneously. Spasm of the glottis is produced, none of the gas being able consequently to enter the lungs, and death is immediate from apnœa. When administered in a *somewhat diluted* state, it will be noticed that there is an immediate loss of muscular power. The patient sinks down, unable to make the slightest exertion, the head falling on the breast, and death resulting without a word or a struggle.

When the acid is still *more diluted*, the patient will complain first of all of irritation in the throat, of weight and pains in the head, of drowsiness, giddiness, and singing in the ears, and of a gradual loss of muscular power. Usually there will be marked lividity of the countenance, and of the surface of the body, accompanied with a violent action of the heart, a hurried respiration, and occasionally, although very rarely, convulsions and vomiting.

These symptoms, however, sooner or later, disappear, and the person dies slowly or quickly in a state of complete coma.

Several important medico-legal questions are suggested here—

1. *Is carbonic acid an actual poison, or is its action* (like hydrogen and nitrogen) *merely negative?* The negatively poisonous action of the gas was held strongly both by Regnault and Bernard, who state that the gas will not destroy life if injected into the blood, or under the skin of an animal. But Bernard's own experiments prove incontestably that carbonic acid is an absolute poison, although oxygen be present in sufficient, or in more than sufficient quantity to support respiration. Bernard, for instance, records that a bird died instantaneously in a mixture of equal parts of oxygen and carbonic acid; that is, in an atmosphere containing three times the per-centage quantity of oxygen that ordinary air contains. He also found a bird died in 2½ hours in an atmosphere consisting in 100 parts, of 9·5 of carbonic acid, 28 of oxygen, and 62·5 of nitrogen; or, in other words, in an atmosphere containing 7 per cent. more oxygen than exists in ordinary air.*

These experiments were confirmed by those of M. Collard de Martigny, who also found that a mixture of carbonic acid and oxygen, the oxygen being present in ordinary atmospheric proportion, produced fatal results, when birds, or even larger animals, were placed in it.

We may conclude, therefore, that carbonic acid is an actual poison, even although a normal or more than normal proportion of oxygen be present.

2. *What amount of carbonic acid must be circulating through the body to cause death?* Bernard admits that carbonic acid enters the blood. He found that, before asphyxia, the amount of carbonic acid present in the blood of an animal was 2·88 per cent.; whilst, after asphyxia had been induced, it amounted to 4·55 per cent. Accordingly, therefore, the difference between 2·88 and 4·55 represents the proportion of carbonic acid in the blood that may prove fatal.

3. *The amount of carbonic acid ordinarily present in air, and the circumstances influencing it.* Air contains ordinarily from 3 to 6 parts of carbonic acid in 10,000. The quantity present is less after rain, increases during a frost, and diminishes during a thaw. It also increases during the night, and diminishes after sunrise; it is less over large tracts of water, than over large tracts of land; it varies less on high mountains, where it is generally in greater quantity than on the plains; it is more abundant in very crowded districts, than in the open country; and it is largely increased in houses and in rooms that are used for public assemblies.

4. And here it will be convenient to examine *the action of air on the living body where the amount of oxygen is diminished without any additional carbonic acid.*

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* Mr. Snow records as the result of his experiments ("Lancet," April 6, 1839, p. 93), that in an atmosphere containing 20 per cent. of carbonic acid, the oxygen being in natural proportion, a white mouse died in one hour and a half, and birds in a few minutes. With 12 per cent. of carbonic acid, the oxygen being normal, a sparrow died in two-and-a-half hours. A white mouse recovered after remaining in the atmosphere for ten hours.

In an atmosphere where the quantity of oxygen was 5 per cent. less than normal, the remainder being nitrogen, Mr. Snow found that one sparrow died in six hours, and that after death the lungs were florid, and the blood fluid. Another sparrow was taken out after being in for half an hour, and was found uninjured.

In an atmosphere where the oxygen was reduced 8 per cent., a sparrow had convulsions in thirty-five minutes. It was then taken out, but it afterwards died, and its lungs were found to be gorged with dark fluid blood. A white mouse recovered after being in the same atmosphere for four hours and three quarters, whilst a green linnet died in ten minutes.

5. *The amount of carbonic acid in air necessary to extinguish a taper.* A taper will readily burn in air containing 8 per cent. of carbonic acid, provided the oxygen be present in normal proportion. With 10 per cent. the flame is very materially dulled; with 12 per cent. the taper goes out, unless it be burning brilliantly before it be introduced; whilst with 16 per cent., however vigorously it may be burning when introduced, it will be extinguished. But the results are very different if, at the same time, the oxygen be decreased. For example, if 3 or 4 per cent. of oxygen be removed (that is, if the oxygen be reduced to about 17 per cent.), and a similar quantity of carbonic acid added as there has been oxygen removed, we shall find a taper will be instantly extinguished.

It is clear therefore that an atmosphere may be dangerous to life in which a taper will burn.

6. *The amount of carbonic acid that must be present in air in order to destroy life.* This question naturally divides itself under two heads.

A. *Where the carbonic acid gas is produced by combustion and respiration at the expense of atmospheric oxygen.*

Questions of some difficulty arise here; for we have to deal not only with the ill effects produced by an increased amount of carbonic acid, but with those resulting from a deficiency of oxygen. These two circumstances co-existing, render the air proportionately more dangerous to life than either cause existing separately. A person dies if obliged to breathe confined air. But it must be particularly noted that death does not, in such cases, result entirely either from the poisonous action of an excess of carbonic acid, or from want of oxygen; but from several other circumstances, such as the perfect saturation of the air with moisture, the abnormally high temperature, and probably above all the decomposing organic matter thrown off by the skin and lungs.

Each adult requires for comfortable respiration about 20 cubic feet of air per hour; and a common candle will vitiate about the same amount in the same time. The air expired contains from 4 to 5 per cent. of carbonic acid. If the same air be again respired, the additional carbonic acid expelled at each inspiration would gradually lessen, until a total was reached of 10 to 12 per cent., and then no more carbonic acid would be given off. An atmosphere under such circumstances must prove fatal. But, although it would probably do so very long before it reached this state, and certainly long before all the oxygen had been used up, it is difficult to draw the exact line of demarcation in such a case between life and death. Nor must we forget in these calculations the different susceptibilities dependent on sex, age, condition, strength, and so forth. Experiments recorded in the "Lancet" (vol. xxxi., p. 201), by Mr. Coathupe, seem to prove that, even with an atmosphere containing 2 per cent. of carbonic acid, the suffering occasioned is severe; whilst Dévergie considers that the presence of 5 per cent. of carbonic acid would ordinarily be sufficient to destroy life. In a crowded, ill-ventilated room, where a large number of persons were congregated, and the atmosphere almost unbearable, not more than 1·18 per cent. of carbonic acid was found to be present.

In considering the question of overcrowding, and the number of people that may be permitted to sleep in a room, 400 cubic feet of air ought to be regarded as the very smallest quantity that should be allowed for each person. Measure the length, breadth, and height of the room. Multiply these together, in order to get its cubic contents. Divide the number by 400, and the quotient expresses the number of persons that may be allowed to sleep in the room.

Example:—A room is 10 feet high, 16 feet long, and 10 feet wide—

$$10 \times 16 \times 10 = 1600.$$

$\frac{1600}{400} = 4$: the number of persons that may sleep in a room of that size.

The following are the requirements of the Poor Law Board:—

Cubic space required by the Poor-Law Board for Dormitories.

Cub. Feet.	
1200	Lying-in-cases and offensive Sick.
850	Sick.
700	Infirm—same room night and day.
500	Infirm—with separate day room.
300	Healthy.

B. *Where air is contaminated by the addition of free carbonic acid.*

The results of experiments bearing on this question are most conflicting, this being due in a great measure to the fact that allowance has not been made for the air present in the lungs at the time of the experiments. It is recorded, for example, that Sir J. Simpson used an atmosphere containing 20 per cent. of carbonic acid, as an anæsthetic, without any bad effects! In short, as Dr. Taylor says, with astonishment, a man may breathe and live in an air in which a candle will not burn! Without discussing all the experiments in detail, it may be broadly stated that the addition of 10 to 15 per cent. of carbonic acid to air, would render it poisonous. Even in an atmosphere containing 5 or 8 per cent. animals often die after varying periods; whilst Dr. Taylor states that in the Cornish mines where the air contains not more than 2 per cent., the miners suffer considerably, although the severe effects are no doubt occasioned by other circumstances than the mere presence of carbonic acid.

7. Several important medico-legal questions have arisen as to *the rate of diffusibility of the carbonic acid produced by combustion.*

On this matter we would merely state—

(1) That there may be parts of a room where, for certain reasons, the carbonic acid is for a time in much greater quantity than in other parts.

(2) That by the law of diffusion even a heavy gas like carbonic acid, will in time diffuse itself equally throughout a room.

(3) That the specific gravity of the carbonic acid generated by combustion is materially lessened by the heat that produces it, the process of diffusion being thereby rendered more rapid.

(4) That once the diffusion is complete, and the gaseous mixture perfect, the separation of the gases does not take place.

In *lime, cement, and brick burning*, carbonic acid is the chief poisonous gas evolved, but it is always more or less mixed with varying proportions of other gases, such as sulphurous acid, carbonic oxide, &c., derived from the materials used as fuel. These may under certain circumstances therefore become dangerous.

Post-Mortem Appearances of Carbonic Acid Poisoning.

They are generally those of death by apnœa. But there are certain characteristics which prove carbonic acid is a specific narcotic poison, as well as an asphyxiating agent. The membranes and the great vessels of the brain are generally found to be extremely congested, serum being effused both in the ventricles, and at the base. Putrefaction after carbonic acid poisoning is slow, and there is a great persistence of animal heat and rigidity. Froth will often be noticed at the mouth and nostrils, and the tongue is frequently found protruded, and grasped by the teeth. The body is often very swollen, the eyes prominent and unusually brilliant, and the blood dark coloured, and liquid. The abdominal viscera are generally much congested.

Treatment.

This must consist in fresh air, and in the inhalation of a small quantity (say about two quarts) of pure oxygen. The cold douche, galvanism, artificial respiration, friction, and perhaps (if there are distinct apoplectic symptoms) a moderate venæsection, must be resorted to as required, and suggested during the progress of the case.

And here, one or two questions bearing on preventive medicine suggest themselves, to which it is our duty to refer.

1. That air in which a candle will burn is not *necessarily* fit to breathe.

2. That charcoal stoves burning in the open air of rooms are dangerous. Accidents have not unfrequently occurred from this cause.

3. That if a man in descending a shaft is seen to drop down insensible, it is folly for one man after another to be allowed to descend with the hopes of rescuing those that have been suffocated.

Tests for Carbonic Acid.

1. Blue litmus is first reddened, and afterwards bleached.
2. If the quantity of acid present exceeds 12 per cent., a taper is extin-

guished, unless the flame be burning very vigorously. If it be above 16 per cent., even a brilliantly burning taper will be put out.

3. It produces a white precipitate, with either lime or baryta-water.

4. To estimate the amount of carbonic acid in a given volume of air, take a measured quantity (say a cubic inch) in a graduated tube, standing over mercury, and introduce into it a solution of caustic potash. Note, after standing for some time, the degree of absorption, which indicates the amount of carbonic acid present.

Vapours from Charcoal Burning, and from Blast Furnaces.

In both these cases carbonic acid and carbonic oxide are evolved. Such a mixed atmosphere is more rapidly fatal than if these gases were present separately. An air containing 5 per cent. of carbonic acid, and 0·5 per cent. of carbonic oxide, will permit the combustion of a taper, but proves rapidly fatal to animal life (Leblanc). Hence the taper test, as we have said, is not infallible, and no charcoal stove should be allowed in a dwelling-room unprovided with a chimney.

The proportions of these gases given off by burning charcoal vary. The quantity of carbonic acid is *least* when the combustion is most active (11 per cent.), and *most* when the combustion is least active (14 per cent.); as, for example, at the beginning and at the end of the operation. The carbonic oxide evolved is usually about 0·5 per cent.

The poisonous effects of burning charcoal, according to Mr. Coathupe ("Lancet," vol. i., 1838-39, pp. 262, 410, 418), are not due so much to these gases, as to certain noxious effluvia (mephitic effluvia), given off at the same time. No doubt there is a certain truth in this statement.

In a case of death from burning charcoal two questions may be asked:—(1) How much charcoal was burnt; and (2) How much charcoal must be burnt to cause death. The first of these questions may be answered by weighing the ashes left after combustion, every 3 or 4 grains of which, corresponds to about 100 grains of wood-charcoal; whilst no satisfactory answer can be given to the second, so much depending on other circumstances, such as the size of the room where the charcoal is burnt, and the consequent dilution of the gas.

The injurious effects of the waste gas from blast furnaces have been studied by Dr. Percy. It is often most improperly used for heating steam-boilers, lime kilns, &c., and accidents consequently have not been uncommon from it. Dr. Percy considers the carbonic oxide is its active ingredient. ("British Medical Journal," July 9, 1870, p. 46.)

CARBONIC OXIDE—CO.

Sp. gr. 0·967.

Preparation and Properties.

Carbonic oxide may be prepared by heating iron or zinc filings with powdered chalk in a gun barrel.

$$Ca\,CO_3 + Fe = CaO + FeO + CO.$$

It may also be prepared by passing dry CO_2 through a red-hot tube containing charcoal. It is often produced in large quantities during combustion in our ordinary stoves and furnaces. Air enters at the bottom of the grate, and carbonic anhydride (CO_2) is formed. This, passing through the fire takes up more carbon, carbonic oxide being in this way produced. It may often be seen burning with a light blue flame at the top of the fire.

Carbonic oxide is a colourless gas, having a faint odour. It does not support combustion, but burns with a pale blue flame, carbonic acid being the only product. It has never been liquefied by cold or pressure. It is but very slightly soluble in water. It is very poisonous.

Symptoms—Dose—Theory of Action—Experiments on Animals.

Carbonic oxide, when respired, passes freely into the lungs, as much as 4 per cent. being found in the blood of animals exposed for from ten to twenty-five seconds to an atmosphere containing 10 per cent. of the gas. When absorbed by the blood it combines with the hæmoglobin. M. Grehaut points out that carbonic oxide is eliminated from the lungs (the organs through which it enters) as carbonic oxide, and may be thus distinguished from gases that undergo combustion in the organism ("British Medical Journal," Jan. 14, 1871). Bernard suggests that the cause of death with *carbonic acid*, is that the blood cannot become *arterial*, but with *carbonic oxide* that it cannot become *venous*. With carbonic acid the symptoms are transitory, but with carbonic oxide they are singularly persistent.

The poisonous action of carbonic oxide was noticed by Guyton Morveau in 1802, and by Sir H. Davy in 1810, who proved, by experiments upon himself, that giddiness, sickness, and debility, were ordinarily produced as the results of breathing the gas. Its injurious effects, when injected into the veins, were originally tried by Nysten. Mr. Higgins, of Dublin, Tourdes, Leblanc, and Letheby, have also experimented with it. *Tourdes* proved that 1 part of the gas in 7 of air killed rabbits in seven minutes—1 in 15 in twenty-three minutes, and 1 in 30 in thirty-seven minutes. *Leblanc and Dumas*' experiments show that air containing 1 per cent. of the gas will kill a dog in one and a half minutes, and that birds will die instantly in an atmosphere containing 5 per cent.

Dr. Letheby found in his experiments that air containing 0·5 per cent. of the gas kills small birds in about three minutes, whilst if it contains 1 per cent. it proves fatal in about half the time. An atmosphere containing 2 per cent. rendered a guinea-pig insensible in two minutes. There were no signs of pain—but the animals fell down insensible and died at once, either with a slight flutter, hardly amounting to convulsions, or gradually slept to death, as if affected with profound coma. Carbonic oxide is, in short, a pure narcotic poison. The blood after death was found redder than usual, the brains a little congested, and the auricles somewhat gorged with blood. Effusion of blood in the brain was always found in the birds that had been poisoned with it.

The large quantity of carbonic oxide (often 34 per cent.) in water gas, would render its employment dangerous as an agent of illumination. Carbonic oxide is found, too, as we have stated, in the neighbourhood of brick-kilns and furnaces. From iron furnaces it is given off to the extent of from 25 to 32 per cent., and from copper furnaces, from 13 to 19 per cent. Under the influence of solar light, Boussingault noticed that the leaves of aquatic plants give off carbonic oxide. May not this be the explanation of the unhealthiness of marsh districts? ("Lancet," March 1, 1862, p. 219.)

To what is the poisonous action of carbonic oxide due?

It has been held that it depends on the formation in the blood of a new and fixed compound of carbonic oxide and hæmoglobin. The belief in the fixed nature of this carbonic-oxide hæmoglobin is the reason why Kühne of Berlin asserts that in carbonic-oxide poisoning, artificial respiration is useless, and that the only chance of saving a patient is the transfusion of arterial blood ("Medical Times and Gazette," June 4, 1864, p. 624. *See* also a successful case of transfusion "British Medical Journal," June 9, 1866, p. 625). Donders, however, has endeavoured to prove that carbonic oxide may be expelled from the blood by such gases as oxygen, hydrogen, and carbonic acid, whilst Zuntz (Pflüger's "Archiv f. Physiol.," v. 584), asserts that it can be separated by the vacuum, but that its separation is fitful, and is not complete by a single exhaustion. The same holds good with respect to nitric-oxide hæmoglobin (Podolinski).

At any rate it is clear that the compound formed is somewhat fixed and stable. The persistently reddened condition of the blood is a special post-mortem characteristic that will be noticed with carbonic oxide, whilst a darkened condition is characteristic of carbonic acid poisoning. Ssabinski regards a bloodless condition of the spleen as a usual effect of carbonic oxide poisoning, the brain being usually congested, and the heart gorged ("Lancet," 1861, vol. i., p. 219).

Toxicological Analysis.

The actual demonstration of the presence of carbonic oxide in the blood should, in medico-legal cases, be attempted—

1. *With the Microspectroscope.* "The absorption band of reduced hæmoglobin does not occur precisely between the two bands of oxyhæmoglobin, since the absorption of hæmoglobin extends further towards the red after reduction than before." This test cannot be relied on if the blood has been long exposed to the air, but if excluded from the air, the spectroscopic appearance can easily be obtained four or five months after death.

2. *With caustic soda* (Hoppe Seyler).
   - (*a*) *Ordinary blood*, shaken up with caustic soda, gives a brownish green precipitate—passing into a red solution, consisting of hæmoglobin transformed into reduced hæmatin.
   - (*β*) *Carbonic oxide blood*, shaken up with caustic soda, gives a red precipitate, passing into a red solution, the red colour being a combination of carbonic oxide with hæmatin, or "carbonic oxide hæmatin," reduced hæmatin being also present. Hence we have a compounded spectrum of reduced hæmatin and of carbonic oxide hæmatin; (similar to carbonic oxide blood, but paler.)

Cases of Poisoning with Carbonic Acid and Carbonic Oxide.

1. Taylor's "Medical Jurisprudence," vol. ii., p. 103 (Dr. Proctor). Female. Death in one hour from carbonic acid, set free by the action of nitric acid on whitening.
2. "Lancet," Nov. 12, 1864, p. 552. Male. Instantaneous death from going into a vat. The candle was found to burn in it.

3. Taylor's "Medical Jurisprudence," vol. ii., p. 112. Death of seven persons from sleeping in the courtyard of a house where limestone was being burnt.
4. "Guy's Hospital Reports," April, 1839. Male. Death from lime-kiln vapours.
5. "British Medical Journal," Feb. 26, 1870, p. 214. Death from lime-kiln vapours.
6. Taylor's "Medical Jurisprudence," vol. ii., p. 112. Death of two boys from brick-kiln vapours.
7. "Medical Gazette," vol. xxvii., p. 693 (Mr. Collambell). Male. Death in two hours from effects of a charcoal-dish. Capacity of chamber 2000 cubic feet.
8. "Edinburgh Medical and Surgical Journal," vol. i., p. 541. Two deaths in prison from effects of burning charcoal.
9. Guy's "Forensic Medicine," p. 603. Recovery, after being in an atmosphere where charcoal was burning, and in which two birds died.
10. "Lancet," Dec. 22, 1838, p. 491. Male, 66. (Case of James Trickey.) Death from charcoal stove at S. Michael's Church.
11. "Lancet," March 23, 1839, p. 18. Male. Death from effects of a charcoal-dish in a ship's cabin.
12. "British Medical Journal," July 5, 1873, p. 21 (Dr. Benson). Two adults. Recovery after severe symptoms, caused by burning charcoal.
13. "Medical Times and Gazette," Jan. 5, 1856, p. 21 (Dr. Ashley). Two females, adults. Recovery from effects of burning charcoal.
14. "British Medical Journal," March 4, 1871, p. 238. Combustion of peat in close chamber.
15. "British Medical Journal," Nov. 9, 1861, p. 508.
16. "Medical Times and Gazette," March 31, 1860, p. 323. Four deaths from burning coal.
17. "Medical Gazette," vol. xxxvi. p. 937.
18. "Edinburgh Monthly Journal," 1860, vol. i., p. 642.
19. "Dublin Medical Press," Jan. 31, 1849, p. 69.
20. "Medical Times and Gazette," April 3, 1852, p. 353.
21. "Medical Times and Gazette," March 31, 1860, p. 323.
22. "Annales d'Hygiène," 1871, vol. ii., p. 441 (M. Dévergie). Female and male. The former died, and the latter recovered from the effects of gases arising from a stove, and getting into a room through fissures in the chimney.
23. "Medical Gazette," vol. xlvii., p. 412. Death from leakage of gases, through an imperfect joint in a furnace flue.
24. Taylor's "Medical Jurisprudence," vol. ii., p. 107. Death from vapours from smouldering ashes.
25. "Annales d'Hygiène," Oct., 1845, p. 369. Death from the fumes of smouldering wood.
26. Taylor's "Medical Jurisprudence," vol. ii., p. 111. Two deaths from coke fire (SO_2?).
27. "Edinburgh Monthly Journal," April, 1847, p. 763 (Dr. Davidson). Death from a fire burning without a flue in a room.
28. "British Medical Journal," Jan. 11, 1862, p. 35 (Dr. Ody). Death from a coal fire, burnt on the hearth, under an open chimney, in which there was a downward current.
29. Percy's "Metallurgy," vol. ii., p. 531. Death from the leakage from a furnace through a brick culvert.
30. Taylor's "Medical Jurisprudence," vol. ii., p. 107. Death of four men from the waste gas from blast furnaces.

COAL GAS.

Composition.

Coal gas is a compound gas, and varies considerably in the relative amount of its several component parts. The differences are due to many causes, such as the kind of coal employed, and the temperature to which it has been subjected, &c. The following are the gases present in coal gas—

1. Hydrogen.
2. Olefiant gas and other heavy hydrocarbons.
3. Light carburetted hydrogen.
4. Carbonic oxide.
5. Carbonic acid.
6. Sulphuretted hydrogen.
7. Ammonia.
8. Oxygen.
9. Nitrogen.

In London gas the amount of carbonic oxide varies from about 5 to 7 per cent.,—light carburetted hydrogen from 40 to 45 per cent., and olefiant gas from 3 to 4 per cent. There is little doubt that carbonic oxide is the most actively poisonous of the gases present. Indeed, some have stated that it is the only poisonous body (M. Tourdes). But it is more than probable, as Dr. Taylor suggests, that the various hydrocarbons present have also a noxious influence. It is curious, however, that, in a very diluted state, *pure* carburetted hydrogen does not appear dangerous to health, inasmuch as the miners breathe it continually without any apparent ill effects resulting. The odour of coal gas, which is due to naphtha vapour and to other volatile hydrocarbons, is its great safeguard; and this odour is very intense. We can ourselves detect 1 part of coal gas in 12,000 of air, and there are few in our experience who cannot recognize 1 part in 8000.

Symptoms—Experiments on Animals.

Experiments on animals with coal gas were made by Dr. Aldis, and are recorded in the "British Medical Journal," (Feb. 1, 1862, p. 126, and March 29, 1862, p. 344). Other experiments are recorded in the July number of the "Edinburgh Medical Journal," 1874. According to our own experiments, an atmosphere containing 4 per cent. has a well-marked injurious action on mice. Two mice out of three died in about five minutes in an atmosphere containing 17 per cent., but the third one for some reason or another recovered. But even when the gas was present in excessively minute quantity, a mouse, as well as a small geranium, became visibly affected after exposure to its influence for a considerable time: the mouse becoming exceedingly quiet, dull, and heavy, with a complete loss of sprightliness, from which state it took some time to recover, whilst the geranium slowly withered and ultimately died.

These experiments show that a very small quantity of coal gas in the atmosphere may, and does produce serious, although not necessarily fatal results. Remembering, therefore, the enormous leakage of gas that is daily going on, and everlastingly tainting the atmosphere, we are led to enquire whether this may not possibly be the cause of many cases of illness the physician finds it difficult to explain. The symptoms of coal gas poisoning may be thus summarised: headache and giddiness, then vomiting, followed by loss of memory, passing on to unconsciousness, with convulsions and loss of muscular power, and finally complete asphyxia. Dr. William Taylor's carefully recorded case ("Edinburgh Medical Journal," July, 1874), shows a close resemblance between coal gas poisoning and apoplexy, except in this one particular, that in apoplexy the symptoms are continuously persistent, whilst in coal gas poisoning they fluctuate—being at one moment hopeful, and at another discouraging. He notes, moreover, the incessant oscillation of the eyeballs in poisoning by coal gas.

Post-Mortem Appearances.

The post-mortem appearances vary, and the variations may possibly be accounted for by one gas predominating at one time and one at another. M. Tourdes regards the following, however, as the appearances that may ordinarily be expected;—coagulation of the blood, a deepened tinge of colour, brilliancy of colouration of the pulmonary tissue, abundant froth in the air passages, engorgement of the vertebral nervous system, and extravasation of coagulated blood in the spinal column, injected state of the mucous membrane at the base of the tongue, and occasional rose-coloured patches on the thighs.

Treatment.

The treatment must consist in fresh air, cold affusion, stimulants, artificial respiration, &c.

Tests.

Coal gas may be known :—

(1.) By its smell.
(2.) By its burning with a white light.
(3.) By its exploding when mixed with 80 to 90 per cent. of air.

Cases of Poisoning with Coal Gas.

<table>
<tr><td colspan="2">1.
" Annales d' Hygiène," Jan. 1842. Also *see* " Monograph " (by M. Tourdes). *See* also " Edinburgh Medical Journal," July, 1874, p. 28. Family.</td></tr>
<tr><td>*Symptoms, &c.*—Breathed coal gas, which had escaped from under the earth, and permeated into the room, for nearly 40 hours. Four of the children were found dead, and the father and mother insensible. The father died—the mother recovered.</td><td>*Post-mortem.*—Congestion of the brain and membranes ; all the air passages intensely injected ; the bladder in 4 cases was filled with an enormous quantity of limpid urine. Intestines natural.</td></tr>
<tr><td colspan="2">2.
" Guy's Hospital Reports," No. 8 (Mr. Teale).</td></tr>
<tr><td colspan="2">3.
"Medico Chirurgical Transactions," 1862, vol. xlv., p. 103 (Mr. Bloxam). Male.</td></tr>
<tr><td>*Symptoms, &c.*—A gas-fitter accidentally breathed coal gas. He was found insensible, sitting in the parlour in which he was at work. Death must have been rapid.</td><td>*Post-mortem.*—Skin pale ; rigidity well marked ; blood black and fluid ; brain healthy, but smelt of coal gas ; lungs dark red, and smelt of gas ; right side of the heart full of fluid blood ; left side empty.</td></tr>
<tr><td colspan="2">4.
" Annales d' Hygiène," 1870, vol. i., p. 60 ; " Lancet," July 6, 1872, p. 32 (Mr. Jackson).</td></tr>
<tr><td>*Symptoms, &c.*—Leakage from a small pipe leading to a gas-stove. A woman died after 4 hours ; her infant (14 days old) was not affected, owing probably to its position ; the nurse, who was found in an insensible state, recovered, under the action of galvanism and artificial respiration.</td><td></td></tr>
<tr><td colspan="2">5.
" Lancet," Jan. 30, 1869, p. 159 (Dr. Sieveking). (1) Male : æt. 55. (2) Male : æt. 33.</td></tr>
<tr><td>*Symptoms, &c.*—Leakage of gas, due to a horse kicking the gaspipe. Insensibility, with stiffness of the arms, occurred in both. About 5 gallons of undiluted oxygen was administered. Recovery in 24 hours.</td><td></td></tr>
<tr><td colspan="2">6.
" Lancet," Oct. 25, 1873, p. 592 (Dr. de Chaumont). (1) Female : æt. 82. (2) Female : æt. 30. (3) Male : æt. 38.</td></tr>
<tr><td>*Symptoms, &c.*—Leakage of gas from syphon of company's main. One recovered, the two others died.</td><td>*Post-mortem.*—Dura mater in both cases was much congested ; lungs dark ; bronchial mucous membrane much congested ; stomach healthy.</td></tr>
<tr><td colspan="2">7.
" Lancet," Oct. 4, 1873, p. 500. Male : child.</td></tr>
<tr><td>*Symptoms, &c.*—Escape of gas into bedroom. Found dead. No sign of struggling.</td><td></td></tr>
</table>

8. "Lancet," Nov. 10, 1866, p. 523 (Dr. Barclay). Male: æt. 23.	
Symptoms, &c.—The man had a fit; after recovery found it difficult to speak; seemed as if intoxicated: pupils natural; vomiting; clonic spasms. Recovered by the next day. Urine natural.	
9. "Lancet," Nov. 10, 1866, p. 523 (Dr. Barclay). Male: æt. 28.	
Symptoms, &c.—Fits, but without loss of consciousness; urine natural; loss of memory and speech; frequent clonic spasms. Recovery.	
10. "Lancet," Dec. 10, 1870, p. 816 (Mr. Jessop). Male: æt. 21.	
Symptoms, &c.—Went into a large gas-pipe to look for place of leakage, supposing all the gas to have been let off. Immediate insensibility; was found and taken out after 20 minutes; convulsions; pupils normal; no foaming of the mouth, or vomiting, or stertorous breathing. Recovered in 2 days.	
11. "Edinburgh Medical Journal," July, 1874 (Dr. Wm. Taylor). Male: æt. 60.	
Symptoms, &c.—Slept all night in a room where coal gas had been escaping (not more than 3 per cent. being present in the atmosphere). Found in the morning unconscious; mouth open; pupils insensible and dilated; breathing laboured; afterwards convulsions set in; jaws became rigid; breath impregnated with gas. (Cold douche, artificial respiration, turpentine enema, used.) Seemed to improve for a time, but died the next day.	
12. "Edinburgh Medical Journal," July, 1874, p. 25 (Drs. Maclagan and Pirie, of Dundee).	
Symptoms, &c.—A man, wife, and 2 children, found dead from gas leakage.	
13. "Edinburgh Medical Journal," July, 1874, p. 27. Male: æt. 14.	
Symptoms, &c.—A boy at a public school died from the gas escaping at night into the bedroom, the stop-cock not having been properly turned.	

NITROUS OXIDE (N_2O.).

(Nitrogen Protoxide—Laughing Gas.)

Preparation and Properties.

It is prepared by heating nitrate of ammonia.

$$H_4N, NO_3 = 2H_2O + N_2O.$$

Nitrous oxide is a colourless gas, with a sweetish smell and taste. At 0°C. 100 cubic inches of water dissolves 130 cubic inches of the gas, and at 23·8°C. 100 cubic inches dissolves 60 cubic inches of the gas. It can be reduced to a liquid by a pressure of 50 atmospheres at a temperature of 1.05° C. The gas has about the same specific gravity as carbonic acid (1·527). It is a brilliant supporter of combustion. It has neither acid nor alkaline properties.

Effects of Inhalation.

Sir H. Davy was the first who pointed out that it might be breathed without danger for a short time, symptoms of transient intoxication being produced. These effects rapidly disappear, and no bad after-effects result. Of late several accidents have occurred from its use as an anæsthetic in dental and other operations. It is to be remembered that nitrous oxide cannot act as a substitute for oxygen, and that undiluted nitrous oxide acts speedily as a poison. Further, if any hydrochloric acid be present in the nitrate of ammonia, a little chlorine, which will prove very injurious, may be generated at the same time. It is generally supposed that the fatal effects resulting from it are due to pure air not being allowed to enter at proper intervals during the exhibition of the gas. The advantages of the gas as an anæsthetic are its rapidity of action, the absence of vomiting, and the rapidity of recovery. But it requires to be watched with great care during administration. It is reported that a patient in New York was kept one hour and thirty-four minutes under its influence. ("New York Medical Journal.") Dr. Marion Sims performed ovariotomy on a patient under the gas, the operation lasting fifty-four minutes. Mr. Colton states that he has administered it 67,455 times, and never had an accident. ("Lancet," Dec. 13, 1873). In about 1 case in 100 there was a little vomiting. (*See* cases of death, "Lancet," Feb. 15, 1873, p. 254, and May 25, 1872, p. 727; "British Medical Journal," April, 1864; "Phil. and Med. Surg. Rep." 1872, p. 343.)

FUMES OF NITRIC, NITROUS ACIDS, &c.

Nitrous acid fumes are very offensive and irritating, and in large quantity deadly. There are several manufacturing processes in which such fumes are generated and escape into the air, unless care be taken. Such, for example, are gun cotton manufactories, and places where brass button making, water gilding, and such like processes are carried on, as well as in badly managed oil of vitriol works, and in oxalic acid manufactories where the acid is produced by the action of nitric acid on saccharine matters. In addition to these, nitrous fumes are generated by the makers of tin and iron liquors, and also at nitro-benzol and picric acid works. To remedy the nuisance, the operations should be carried on in closed vessels, and an apparatus employed whereby the nitrous fumes may be absorbed by passing them either through water or through an alkaline liquid containing milk of lime. If habitually breathed, even in very small quantities, and in great dilution, they are likely to produce bad chronic diseases, and in larger quantities, acute symptoms. The symptoms are generally a great tightness in the chest, with a dry cough, the patient calling out for air as if dreading suffocation—a constant feeling of nausea, pain in the stomach, dysuria, delirium, and death in or after convulsions. Acute inflammatory action will be found along the whole of the respiratory tract. An active supervision of such manufactories is very necessary to prevent serious mischief.

Cases of Poisoning by Nitrous Fumes.

<table>
<tr><td colspan="3">1.
"Lancet," April 15, 1854, p. 430. Male: adult. Fumes from a broken carboy of nitric and sulphuric acids. Inhaled fumes for a few minutes.</td></tr>
<tr><td>*Symptoms.*—No effects particularly for 3 hours, except coughing, after which difficulty of breathing set in.</td><td>*Result.*—Death in 11 hours.</td><td>*Post-mortem.*—Congestion and effusion of blood into the bronchial tubes.</td></tr>
<tr><td colspan="3">2.
"Chemical News," March 14, 1863, p. 132. Male: adult. Broke a jar of nitric acid, and inhaled the vapour.</td></tr>
<tr><td>*Symptoms.*—Difficulty of breathing did not occur for an hour or two.</td><td>*Result.*—Death in 10 hours.</td><td></td></tr>
<tr><td colspan="3">3.
"Chemical News," March 14, 1869, p. 132. Male: adult. Broke a jar of nitric acid. and inhaled the vapour.</td></tr>
<tr><td>*Symptoms.*—Difficulty of breathing did not occur for a few hours.</td><td>*Result.*—Death in 15 hours.</td><td></td></tr>
</table>

PHOSPHORETTED HYDROGEN (PH_3).

(Sp. gr. 1·24.)

A case of suspected poisoning is recorded by Brenner ("Sydenham Society's Biennial Retrospect," 1865-66, p. 443).

SELENIURETTED HYDROGEN (H_2Se).

(Sp. Gr. 2·795.)

This is produced by acting on selenide of iron or of potassium with dilute hydrochloric or sulphuric acids. It is intensely poisonous. Berzelius, experimenting on himself, found a bubble of the gas not larger than a pea deprived him of the sense of smell for several hours.

SULPHURETTED HYDROGEN (H_2S).

(Sp. Gr. 1·1912.)

Preparation and circumstances under which it is produced.

Sulphuretted hydrogen is prepared by adding dilute sulphuric acid to sulphide of iron. It is produced in small quantity when sulphur is heated in hydrogen. It is formed spontaneously whenever a soluble sulphate remains in contact with decaying organic matter, provided the amount of air present be limited; a sulphide being first formed, the excess of oxygen combining with the decaying organic matter ($Na_2SO_4 + 2O_2 = Na_2S$, &c.). Any acid, even carbonic acid, will now set free the sulphuretted hydrogen ($Na_2S + H_2O + CO_2 = Na_2CO_3 + H_2S$). It is in this way that the Harrogate spring becomes loaded with the gas, to which it owes its unpleasant taste, but supposed medicinal properties, whilst by a similar action sulphuretted hydrogen is generated in sewers and cesspools. The occasional bad taste of soda and other effervescent waters, is due to a minute trace of the gas being generated, owing to common water containing sulphates and organic matter being used in their manufacture.

Properties.

Sulphuretted hydrogen is a colourless, transparent gas, having an intense odour of rotten eggs. Water at 0° C. dissolves 4·37 times its bulk, and at 15° C. 3·23 times its bulk of the gas. If the solution be allowed to stand exposed to the air or oxygen, water is formed, and the liquid becomes turbid from the deposition of sulphur.

$$2\ H_2 S + O_2 = 2\ H_2 O + S_2.$$

A little sulphuric acid is formed if the oxidation takes place in a moist atmosphere.

Sulphuretted hydrogen is a combustible gas, and burns with a pale blue flame, producing water and sulphurous anhydride. If the amount of air be limited, sulphur will be deposited. Transmitted through tubes heated to redness, sulphuretted hydrogen is partially decomposed into sulphur and free hydrogen. In the presence of moisture, sulphurous acid and sulphuretted hydrogen decompose each other. It is also decomposed by the haloid elements. It will explode when mixed with one-half its volume of oxygen, sulphur being deposited, but if it be exploded in the proportion of 2 of sulphuretted hydrogen and 3 of oxygen, sulphurous acid only is formed.

A pressure of 17 atmospheres reduces the gas at a temperature of 15°C. to a colourless mobile liquid.

Symptoms.

The symptoms of poisoning by sulphuretted hydrogen vary according to the degree of its dilution. If *very concentrated*, death is immediate. If *somewhat diluted*, nausea, giddiness, cold skin, laborious breathing, irregular action of the heart, pains in the stomach, and death by coma, or perhaps in violent convulsions, with tetanus and even delirium, are not unusual. *If in a greater degree of dilution*, sleepiness merely will be produced, from which recovery is easy, if proper means be adopted, but may otherwise terminate fatally without sensibility being restored; if respired in *an exceedingly dilute form* a train of febrile symptoms, somewhat resembling typhoid in their character, will be observed, a feeling of nausea probably being the first symptom complained of. The pupils will generally be found dilated.

Experiments on Animals.

The results of the experiments of Parent du Chatelet, Barker, and Letheby, on animals with the gas, may be thus tabulated:—

1 of H_2 S in	1,500	of air killed	small birds	Parent du Chatelet.
1 ,,	290	,,	rabbits	
1 ,,	250	,,	horses	
1 ,,	1,800	,,	birds	Dr. Barker.
1 ,,	210	,,	dogs	
1 ,,	2,000	,,	birds	Dr. Letheby.
1 ,,	200	,,	dogs	

Dr. Letheby considers that 1 per cent. of the gas in air would be destructive to human life.

According to Dr. Donovan, even the mere application of the gas to the skin is dangerous. It is intensely fatal if injected into the blood or into the cavities of the body.

Sewer Gases.

All the cases of poisoning by sulphuretted hydrogen that are recorded have been accidental. Indeed, it could not well be otherwise. The fatal cases have generally happened during the removal of night-soil; and from the less care that is probably taken, such accidental cases seem to be commoner on the Continent than in England. A mere feculent odour is not necessarily injurious, nor is there much danger to be apprehended from sewers where the supply of water is liberal. Previously to emptying cesspools, privies, sewers, and the like, they should be well stirred up, as otherwise the escape of noxious vapours may take place as soon as the removal of the soil commences. It is not enough to find that a candle will burn in the atmosphere of a cesspool, because even then it may be dangerously charged. Further (and this is also true in the case of vaults), they should, before entry, be freely exposed to the air, an active combustion set up, and chlorine generated in them for two or three days before the men are allowed to enter.

The sewer gas is generally a mixture of sulphuretted hydrogen, sulphide of ammonium, and nitrogen, but sometimes, according to Thénard, it is a mere deoxidized air with excess of carbonic acid. In such cases (and recovery is more hopeful under this latter condition) the want of oxygen is the true cause of the asphyxia rather than the amount of carbonic acid, which is not likely to exceed 4 per cent.

The accidents in the Fleet-lane sewer in February, 1861, were carefully investigated by Dr. Letheby ("Lancet," Feb. 23, 1861, pp. 187 and 455). Sulphuretted hydrogen was undoubtedly the cause of the deaths. Was it due (1) to the discharge of some liquid into the sewer, like gas liquor, saturated with sulphuretted hydrogen, or (2) to the escape of the gas from the disturbed mud in the sewer, or (3) to the action of some acid liquor let into the sewer, upon the sulphides contained in the mud? Dr. Letheby believed it due to the last cause. The time of the accident coincided with the letting into the sewer about 100 gallons of acid liquor ("sharps") from a founder's and brass-finisher's. This acid liquor consisted of the washings of the brass after it had been steeped in nitric acid. Undoubtedly acid liquor should not be allowed to escape into the sewers at all; but there was some doubt whether, in this case, it could be traced directly to it. Dr. Letheby believes that all danger would be averted by the men at work using charcoal respirators.

The composition of the air of the City sewers is thus stated by Dr. Letheby:—

Traces of ammonia—marsh gas—and sulphuretted hydrogen.

Nitrogen	79·96
Oxygen	19·51
Carbonic Acid . . .	0·53

Emanations given off from dead bodies have for centuries been regarded with special dread. These gaseous emanations are chiefly ammonia, sulphuretted hydrogen, carbonic acid, phosphuretted hydrogen, and carburetted hydrogen. Necessarily putrefaction is delayed when a body is buried in lead, but the metal gives way at last from its conversion into a carbonate. The removal of bodies from the London churches to the cemetery was effected with perfect safety by enclosing them separately in a shell of such a size that there was at least two inches between the coffin and the shell, this space being filled up with a mixture of equal parts of charcoal, carbolate of lime, and earth. There is every reason to believe that the accounts given of the evils that have arisen from dead bodies, are much exaggerated ; few such cases are on record, except accidents arising from the exhumation of recently interred bodies where the abdomen and other parts were distended with gases, and in such cases as these, accidents are easily explained in other ways. (*Vide* "Lancet," Dec. 7, 1839, p. 411, and March 14, 1840, p. 936.)

Treatment of Sulphuretted Hydrogen Poisoning.

The treatment is fresh air and cold affusion. The respiration at times of air containing a trace of chlorine should be tried, and this can be easily effected by making the person breathe from out of a bottle containing a small quantity of chloride of lime. Hot brandy-and-water may be given freely.

Post-Mortem Appearances.

The post-mortem appearances are fairly constant. The blood is fluid and of a dark black colour, the poison being actually absorbed by the blood, and chemical changes thereby effected. There is a general distension of the viscera, rapidity of putrefaction, and the exhalation from the body of an offensive odour. The right side of the heart is usually gorged with blood. The muscles generally are dark coloured. All the larger bronchial tubes (and this is a very characteristic appearance after sulphuretted hydrogen poisoning) appear as if smeared with a dirty brown deposit, which can be wiped off with the finger. By this means there is no difficulty after death, in deciding whether the fatal result was due to sulphuretted hydrogen or to carbonic acid.

Tests.

(*a*) *The vapour of sulphuretted hydrogen is known—*

1. By its odour of rotten eggs : 1 part in 10,000 can be easily noted by the smell.
2. White filter paper moistened with a solution of *acetate of lead*, or any other salt of lead, is immediately blackened.

Sulphuretted hydrogen in solution is similarly known by the blackening effect on the addition of a lead salt.

(*β*) *The vapour of sulphide of ammonium is known, in addition to the above tests—*

(1) By its turning turmeric paper brown.
(2) By the white fumes produced with hydrochloric acid.

(3) By a crimson colour being produced with *nitro-prusside of sodium.* This may be exposed to the action of the gas on a piece of filter paper, moistened with a solution of the salt. This test produces no action with H_2S.

Toxicological Analysis.

If the body suspected to have been poisoned by sulphuretted hydrogen can be examined immediately, either place in a cut made in a thick muscle, or, better still, put under the skin, a strip of bright silver, or a piece of lead paper, and note the changes that result. If sulphuretted hydrogen be present, the silver or the lead paper will be blackened. This test will be of no value, however, unless the experiment be made immediately after death, because (1) the sulphuretted hydrogen is only retained by the tissues for a short time, and (2) if any putrefaction process has been set up, the test is worthless. And this will further show the necessity in such cases for special examination of the locality where the accident happened, as reliable evidence of poisoning by sulphuretted hydrogen can scarcely be obtained from an examination of the body itself.

Cases of Poisoning with Sulphuretted Hydrogen, Sewer Emanations, &c.

1.

"Annales d'Hygiène," July. 1836 (M. d'Arcet). Males (3): adults. Three men died successively within a few years, from sewer emanations evolved from a pipe leading from the privy into the room where they lived.

2.

Taylor's "Medical Jurisprudence," vol. ii., p. 120. The men working in the Thames Tunnel were found to suffer severely. Several died. Dr. Taylor found this to be due to the air containing sulphuretted hydrogen.

3.

"Medical Times and Gazette," July 1, 1871, p. 9. Sewer gas.

4.

"Medical Gazette," vol. xliii., p. 871.

5.

"Lancet," Feb. 17, 1872, p. 243. Sewer gas.

6.

"Lancet," June 29, 1872, p. 895. Sewer gas.

7.

"Lancet," April 15, 1848, p. 413. Sewer-gas.

8.

"Lancet," Feb. 23, 1861, p. 187 (Dr. Letheby and Mr. Holden). Males (4): adults. Sewer gas.

9.

Taylor's "Medical Jurisprudence," vol. ii, p. 121. Six persons. All six slept in a room containing a minute trace of H_2S. The cottages were built on slag containing the sulphides of iron and calcium, and the day before the accident there had been a sharp shower of rain. (1 and 2) The father and mother were found dead in the morning. (3) A child was found insensible, and died in the afternoon. (4) An adult slept in the same bed, and was dead after an hour. (5 and 6) Two children also died.

10.

Taylor's "Medical Jurisprudence," vol. ii., p. 124 (Mr. Eager Guildford). Male: adult. From cleaning out a tank used as a cesspool. The man fell in, but was rescued in three minutes. Coma. Death in 24 hours.

11.

Taylor's "Medical Jurisprudence," vol. ii., p. 124. Male: adult. Cleaning out a cesspool in which oil of vitriol had been poured. Death.

12.

"Christison," p. 810. Twenty-two boys. All attacked, and two died, from the effect of gases escaping into the garden from a cesspool.

13.

Taylor's "Medical Jurisprudence," vol. ii., p. 126. Three men. Died from breathing gases emanating from an old sewer. Two men were nearly killed in endeavouring to rescue them.

14.

"British Medical Journal," Aug. 14, 1869, p. 188. Two deaths in sewers at Dublin, arising from gas lime being thrown into the sewer.

SULPHUROUS ACID (SO_2).

(Sulphur Dioxide. Sp. gr. of gas 2·247, and of liquid 1·38 at 16°C.)

Sources and Properties.

Sulphurous acid is produced by burning sulphur in air or oxygen. It is also one of the gases (as well as carbonic acid and carbonic oxide) produced by the combustion of coal and coke, and derived from the oxidation of the sulphur. The amount of sulphur in different specimens of coal and coke varies greatly.

Amount of Sulphur in different varieties of Coal.

	Maximum.	Minimum.	Average.
Wales ...	5·07	0·09	36 exps. 1·47
Newcastle ...	2·85	0·06	18 „ 1·24
Derbyshire ...	1·30	0·80	7 „ 1·01
Lancashire ...	3·04	0·52	28 „ 1·43
Scotland ...	1·57	0·33	8 „ 1·11

The amount of sulphur in coke is generally about one-half of the total quantity present in the coal from which it is prepared. Sulphurous acid is also given off freely from the craters of volcanoes, and consequently may be ordinarily found in the springs of volcanic districts. It is produced also by burning ordinary coal gas, from the oxidation of the sulphur compounds present.

Sulphurous acid is a colourless gas, having an intensely suffocating odour, and a pungent taste. It is neither combustible nor a supporter of combustion. Water dissolves about forty times its bulk. It possesses great bleaching powers, but it does not, like chlorine, destroy the colour, proved by the fact that it can be again restored by an alkali, or by the action of a stronger acid.

Its uses are numerous: amongst others for bleaching, as a preservative of meat, to check fermentation, and for purposes of fumigation.

Poisonous Effects of the Gas.

In excess, of course, sulphurous acid is a poison ; but it is remarkable how easily animals become accustomed to inhaling it in small quantity. A quantity of the gas that is positively poisonous to one, can be respired with perfect impunity by another that has been cautiously, and by degrees, accustomed to its action. For example, we placed two mice in a large glass receiver, in which we burnt 0·5 grain of sulphur. The effect was immediate, and the irritability caused lasted for some time; but by increasing the amount of the sulphur gradually day by day, we were enabled to burn 10·0 grains of sulphur in the same vessel without anything like the irritating effect on these two mice resulting, that 0·5 grain produced in the first instance. We do not think that when the slight irritability that sulphurous acid produces in small quantity is in the first instance overcome, that it acts injuriously ; rather, indeed, it may be antiseptic in its action, and positively beneficial. Some years ago, when Dr. Letheby was examining the air of the Underground Railway, it was remarked that the men constantly engaged on that line suffered little or no inconvenience from the sulphurous acid present in the air. It is to be remarked that we have failed to train plants to bear its action in the same manner as we have trained mice. A very much smaller quantity of sulphurous acid will destroy a plant than is necessary to kill a small animal like a sparrow.

Tests for Sulphurous Acid.

1. Its intensely suffocating odour.
2. It produces a blue colour, with starch and iodic acid. One part in 3,000 can be easily detected by this test.

CHAPTER XVIII.

COMPOUND POISONING.

Cases of mixed or compound poisoning are not uncommon. Sometimes the symptoms consist of a combination of those usually resulting from the several poisons taken. At other times the symptoms of the one poison, which is the most powerful, or which is present in the greatest quantity, seem entirely to overwhelm the action of other poisonous bodies with which it may be mixed. Sometimes a new set of symptoms are produced, entirely differing from the symptoms produced by either poison. At other times the intense action of one poison seems to be more or less completely destroyed by the action of the second. This is notably the case where opiates are given in combination; as, for example, in a mixture of opium and oxalic acid. The treatment in all cases of compound poisoning will depend on the poisons taken, and must be specially suggested by the character and nature of the symptoms.

The following is a list of some cases of compound poisoning that are on record:—

Compound Poisoning.

"British Medical Journal," Jan. 22, 1870, p. 86. (ʒiiss of aconite tincture and ʒj of chloroform. Recovery. No vomiting for three hours.)

"Medical Times and Gazette," Nov. 12, 1864. (Liniment of ammonia, oil, and cantharides. Recovery.)

"Medical Times and Gazette," Dec. 1, 1855, p. 560. (Arsenic and phosphorus. Rat poison.)

"Medical Times and Gazette," April 11, 1857, p. 368. (Arsenic and antimony.)

"Medical Times and Gazette," Sep. 14, 1850, p. 296. (Poppy heads and marigolds, boiled in water, given to a child, æt. five weeks. Death.)

"Medical Times and Gazette," March 18, 1865, p. 299. (Death from arnica and opium.)

"Lancet," vol. ii., 1865, pp. 69, 79, 80-95 (Glasgow poisoning case. Aconite and laudanum.)

"Medical Times and Gazette," Dec. 5, 1857, p. 587. (A packet of vermin-killer with two drams of tincture of opium, and half a dram of red precipitate. No convulsions or twitchings of any kind occurred.)

"British Medical Journal," June 24, 1865, p. 657. (Suspected slow poisoning from sulphate of iron and zinc.)

"British Medical Journal," July 13, 1867, p. 29. (Large dose of camphor and belladonna. Death.)

"British Medical Journal," Feb. 29, 1868, p. 204. (Laudanum and ipecacuanha. Death.)

"Lancet," Aug. 30, 1856, p. 248. (ʒij—ʒiij of sulphate of iron, and ʒvii of sulphate of copper. Death in 48 hours.)

"Lancet," Feb. 5, 1853, p. 139. (Aconite and morphia. Death.)

"Medico-Chirurgical Review," Jan., 1854. (Chrome yellow and arsenic.)

"Medical Times," Oct. 3, 1848, p. 58. (Laudanum and arsenic. Narcotism. Death in 18 hours.)

"Medical Times and Gazette," Dec. 19, 1863, p. 645. (Acetate of lead and ammonio-chloride of mercury.)

"Lancet," Dec. 23, 1871, p. 907. (Strychnia, red precipitate, and laudanum.)

"Lancet," March 29, 1862, p. 326. (Laudanum and gin. Death.)

Taylor's "Medical Jurisprudence," vol. i., p. 426. (Aconite and morphia. Death.)

"Medical Times and Gazette," Nov. 3, 1866, p. 473. (Belladonna and opium.)

Taylor's "Medical Jurisprudence," vol. i., p. 432. (Belladonna and opium.)

CHAPTER XIX.

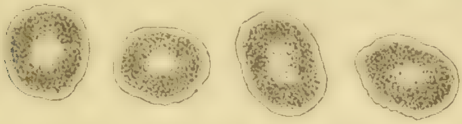
EXAMINATION OF HAIRS AND STAINS.

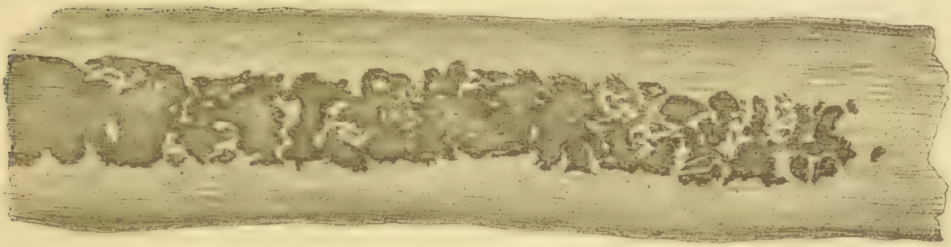
Hairs—Fibres of linen, silk, cotton, &c.—Micrometer measurements—*Seminal Stains*—Tests—Method of examining a suspected stain—Microscopic appearance of the seminal animalcules—Bodies with which they may be confounded—*Blood stains*—Naked-eye appearance—Action of cold water—*Chemical tests*—Stains likely to be mistaken for blood stains by the naked-eye appearance—*Spectroscopic test*—History of the test—Chemistry of the blood-colouring matter—Changes in the colour of blood stains—Blood spectra—The micro-spectroscope—Examination of a recent stain on a white fabric—Examination of old stains, and of stains on coloured fabrics—Examination of stained fabrics that have been washed, and the treatment to be adopted in detecting blood in the water used for washing them—Examination of stains on leather—Examination of stains on earth, and on clothes soiled with earthy matters—Examination of urine for blood—Substances producing spectra likely to be mistaken for blood—Precautions to be observed in conducting micro-spectroscopic observations—*Microscopic test*—Differences in the blood corpuscles of different animals—Microscopic examination of a blood stain—Bodies likely to be mistaken for blood corpuscles under the microscope—*Day's guaiacum resin test*—*Blood crystals*—Teichmann's test—Methods suggested for distinguishing human from other blood—Menstrual blood.

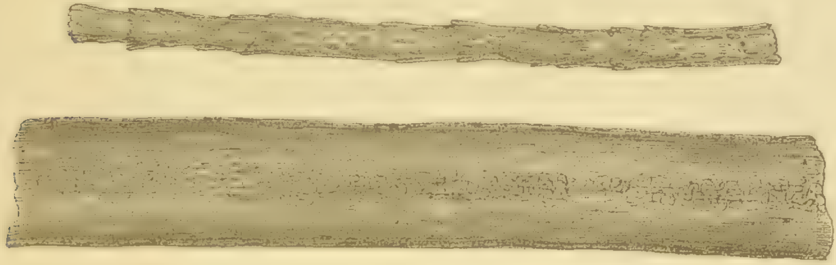
Hairs, Fibres of Linen, Silk, Cotton, &c. Micrometer Measurements.

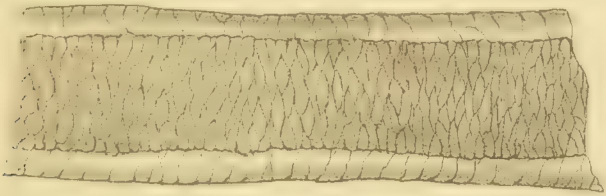
Blood-stains, wounds, seminal stains, and other suspicious-looking spots, often contain hairs from men or other animals, or portions of some fabric, worn by either the victim or the assailant. These substances may also be found upon weapons, and are often handed to the medical jurist for examination. In some cases the microscopic examination of hairs has led to the conviction of a murderer. Dr. Taylor mentions such cases, and the authors know of others. In one case a woman was proved to have spots of blood with rabbit's hairs upon her clothing, and as her murdered child had worn a victorine of rabbit's fur around its neck, this circumstance was considered to be a strong link in the chain of evidence. So numerous are the varieties of hair used in furs, and so many are the vegetable and other fabrics employed in articles of clothing, that it is evident that special knowledge must be required to settle such questions. Sometimes, indeed, it may be impossible to give a definite answer to the question, "What hair or fibre is this?" It is, however, very easy to acquire familiarity with the fibres of wool, silk, cotton, and linen, and to distinguish human hairs from those of many other animals. The illustrations in plates vj, vij, and viij, are all drawn to one scale, and the hairs have all been subjected to the same process: *i.e.*, they have been steeped for some time in turpentine, and then mounted in Canada Balsam. Sonnenschein points out, and figures, the adhesion of spermatozoa to hairs from the genitals in cases of rape. In ordinary cases a magnifying power of from 200—300 diameters will be found quite sufficient to identify the various hairs and

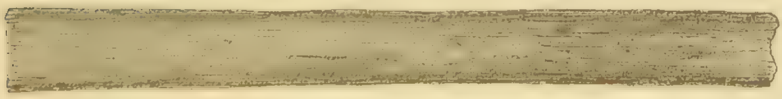
Red Hair from Head. (Human) × 200

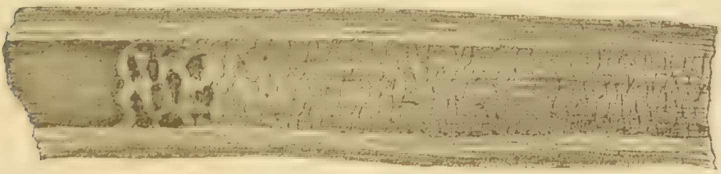

Transverse Sections of Hairs from Head. × 200


Hair from Beard of dark Man. × 200


Hairs from back of Hand (dark Man) × 200


Goat's Hair. × 200


Hair from back of Horse. × 200


Hair from back of Donkey. × 200.

J. Needham del. E. Burgess lith.

W. West & Co imp.

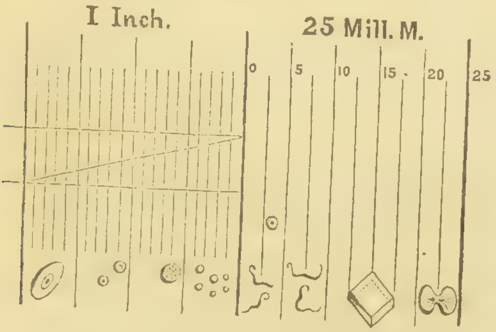
fibres. Such powers are preferable to higher ones, because they permit the use of polarized light, which is often of great service in such investigations.

Those who are not familiar with the microscope often find great difficulty in understanding the magnitudes of microscopic objects, and the measurements of blood-discs, hairs, spermatozoa, &c., given in medical books. The figure given below (Fig. 45) may perhaps assist in explaining the principles of micrometry.

The scale on the left contains one inch divided into 20 parts, or, by means of the diagonal line, as small a part as $\frac{1}{80}$th of an inch may be measured off. On the right, nearly the same space is divided into millimètres, each division representing $2\frac{1}{2}$ of these. Let us suppose a goat's hair, which is about one five-hundredth ($\frac{1}{500}$) of an inch in diameter (equals 0·05 millimètre), magnified 250 times. The $\frac{250}{500} = \frac{1}{2}$. It would, therefore appear half an inch in size, and fill up two of the large, or ten of the small divisions on the inch scale, and five of those on the right-hand side, or 12·5 millimètres.

But the blood-disc of a sheep is only about $\frac{1}{5000}$th of an inch in diameter; so that, if magnified 250 diameters, it would only fill $\frac{1}{20}$th of an inch, or one of the divisions on the left of the figure; which equals 1·25 millimètres, or just half one of the spaces on the right-hand side. In the figure, a frog's blood-disc is seen filling four of the ($\frac{1}{20}$ inch) spaces on the left; it therefore appears $\frac{1}{5}$th of an inch in length. Now, as previous measurements have shown us that the average length of a frog's red blood-disc is about $\frac{1}{1100}$th of an inch, we know that the magnifying power is about 220 times, for $\frac{220}{1100} = \frac{1}{5}$. In the same way, the rhomboidal crystal on the right measures two of the spaces, which equal $2\frac{1}{2}$ millimètres each. It therefore appears to be 5 millimètres in diameter. If seen with the same power as the frog's blood-disc above, its real length will therefore be about $\frac{1}{1100}$th of an inch, for $\frac{5}{220} = \frac{1}{44}$ of a millimètre, or $\frac{1}{1100}$ of an inch nearly.

FIG. 45.



Hairs from different parts of the human body, as well as hairs from different individuals of the same species amongst animals, may vary considerably in size, as will appear from the following table (chiefly taken from Dr. Emil Pfaff's work "Das Menschliche Haar, &c.," Leipsic, 1866, quoted by Sonnenschein). The originals have been reduced to fractions of an English inch.

Lanugo (down) from a suckling	$\frac{1}{3333}$ to $\frac{1}{250}$.
Lanugo from a young girl's arm	$\frac{1}{1666}$.
Lanugo from the upper lip of a woman	$\frac{1}{1428}$.
Hairs from the arm of a man	$\frac{1}{1100}$ to $\frac{1}{666}$.
Hairs from the eyelashes of a man	$\frac{1}{666}$.
Tragi (from the ears)	$\frac{1}{555}$.
Hair from woman's head (capilli)	$\frac{1}{431}$.
Hair from man's head (capilli)	$\frac{1}{333}$.
Hair from hand of man	$\frac{1}{370}$.
Vibrissæ from nostrils	$\frac{1}{333}$.
Male pubes	$\frac{1}{233}$.
Female pubes	$\frac{1}{166}$.
Iulus (first down of beard)	$\frac{1}{166}$.
Eyebrows	$\frac{1}{200}$.
Mystax (Moustache)	$\frac{1}{200}$ to $\frac{1}{181}$.
Hairs from axilla	$\frac{1}{166}$.
Pig's Bristle	$\frac{1}{100}$.
Hair of spaniel dog	$\frac{1}{1100}$.
„ rabbit	$\frac{1}{1125}$.
„ horse	$\frac{1}{340}$.
„ goat	$\frac{1}{500}$.
„ fox	$\frac{1}{600}$.
„ cow	$\frac{1}{600}$.
„ fallow deer	$\frac{1}{250}$.

If we analyse the above table, we find that human hairs have a diameter varying from the $\frac{1}{170}$th to about the $\frac{1}{3000}$th of an inch, according to age, sex, and situation. It will be seen that hairs from the female head are generally finer, as well as softer, longer, and more inclined to curl, than those from the male. Those of children are also softer, more silky and finer than those of adults. But there are exceptions. The student should make himself familiar with the appearances of horizontal sections of the various hairs likely to come into question in such matters. Plate vj shows such sections of human hairs.

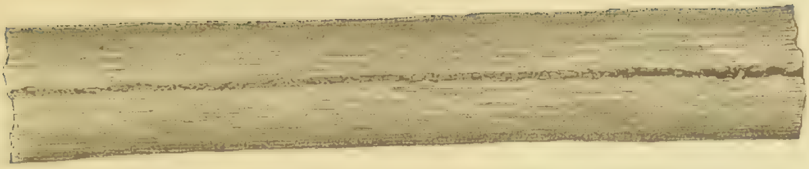
The questions respecting hairs, &c., likely to be submitted to you are—

1. Is it hair, or some other fibre ?
2. If it be hair, is it human ? or that of some other animal ?
3. If it is human, is it male or female ? And from what part of the body does it come ?
4. Has the hair been cut, or torn out, or has any artificial colouring or bleaching been used ?

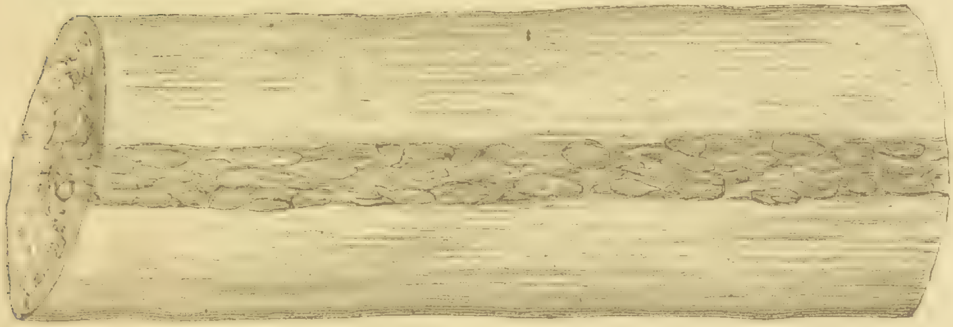
I. As regards the first question, microscopists will have but little difficulty in responding.

The twisted or spiral structure of the flattened bands of *cotton ;* the rectilinear form of *linen* fibres, with jointed markings, at unequal distances, its fibres tapering to a point ; the cylindrical form of *silk*, almost free from markings of any kind, and refracting light most powerfully; the clearly vegetable structure of the fibres of bast-matting and of *jute*, are all easily recognised. *Wool* is a variety of hair ; its fibres are irregular, of unequal thickness, and there are peculiar markings upon it. (*See* Plate vij.)

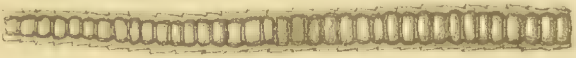
II. The second question is also tolerably easy to answer in the majority of cases. Human hairs are peculiar in having their cortical substance so extremely thin, and marked more than that of any other



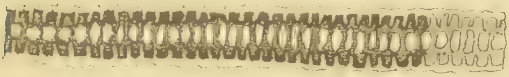
Hair from back of Ox. ×200.



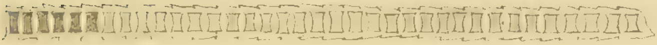
Pig's Bristle ×200.



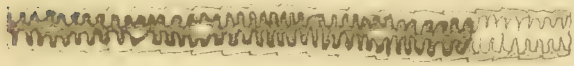
Hair of Cat. ×200



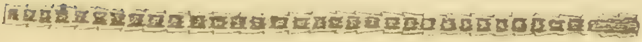
×200



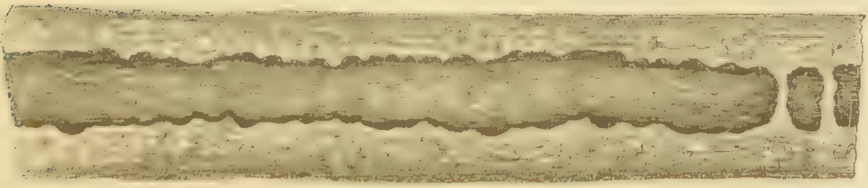
Hairs from Mouse.



×200



Hairs from Chinchilla.



Hair of Seal. ×200

J. Needham del. E Burgess lith.

W West & Co imp

mammals by fine transverse lines; and in the interior of those from the head there is usually an axis-band or cylinder formed of spheroidal cells. Some writers consider that the *medulla* is deficient, and the cortex redundant; but, in our opinion, this is a misnomer. Many animals, particularly rodents and the carnivora, have very peculiar hairs, some of which are well shown in the figures. Seals and some others have two widely different kinds of fur.

III. The question as to male or female has already been in part answered in the preliminary remarks. It may often, indeed almost always, be advisable to compare the suspected hairs with others (respecting which there is no doubt) from the body of the murderer, or of the victim, or of the animal whose hair we believe it to be. Female hairs are generally some $\frac{1}{1250}$ or $\frac{1}{1300}$ of an inch less in diameter than male ones; and the *root* of the male hairs is some $\frac{1}{500}$ of an inch to $\frac{1}{300}$ wider than that of female ones. Men's hairs, if uncut, have also a broader point. Alkalies affect them much less than they do female hairs.

The question as to the part of the body may sometimes be settled partly by the diameters, partly by the general appearance. Those of the eyebrows are generally firm at the point, smooth, angular or oval on section, with a stout, knob-like bulb. The eyelashes have spindle-shaped roots. Hairs from the nose and ears are coarser, and have stout roots. The hairs of the beard and moustache are much modified by shaving and cutting, and those of the axilla by perspiration. The shaft of the latter rises immediately out of the thick root, and does not taper; the points are conical, but not sharp; the colour generally light, from the perspiration. The hairs on the back of the hand, and those on the fore-arm, are often much modified by friction and soap, which fray them. Their roots are club-shaped. The pubic hairs are generally much flattened, and often present considerable roughnesses, through loosening of the epidermic scales of the cortex, so as almost to appear branched when seen under the microscope. Their roots are knotty, particularly in the male; and the usual rule of size is somewhat reversed, those of the female (see table) being generally rather broader than those of the male. The roots of the hairs of the scrotum are particularly long in aged adults, as the hairs are deeply imbedded there.

IV. Has the hair been lately cut or shaved, or has it been torn out violently?

Hairs which are cut with scissors, &c., retain a certain smoothness of section for many days; but hairs violently torn out by force are generally crushed and somewhat frayed, and the hair-sheath is also generally torn out, along with the bulb.

It must, however, be noted that hairs lost after fevers, and other acute diseases, resemble those torn out, as regards the bulbs and hair-sheaths. Epidermic scales from the skin will often be found along with those torn out, and there may even be blood in small quantities. Arsenical and narcotic poisoning and ringworm will cause the hairs to come out of the head, &c., very easily. It is well known that syphilis has the same effect.

V. Has the hair been bleached, or dyed, or changed its colour? The sudden bleaching of the hair by grief or fright has been much disputed, although numerous instances are recorded (Mary, Queen of

Scots: Marie Antoinette, &c.). It is, however, certain that the hair may slowly change its colour from these causes. As a rule, the hair of children darkens greatly as they advance in life; and a man at forty-five is sometimes grayer than one ten or fifteen years older. Certain soils change the colour of the hair of bodies buried in them, an effect which has been attributed to humic acid (Ulmin ?). The hair may be bleached by chlorine, and changed in colour by chloride of gold solution; the exact tint depending partly on its original colour, partly on the strength of the solution. Acetic, citric, hydrochloric, and some other acids, produce similar effects.

The hair is, however, generally roughened by these processes. Alkalies produce similar effects, though they generally restore the colour of hairs bleached by acids. Strong alkalies dissolve hairs. Alcohol renders them more or less transparent, but does not dissolve them. Lead, silver, bismuth, and other metals, whose sulphides are dark, are often used as dyes. Usually speaking, weak nitric acid will dissolve out these, without destroying the hair. Hairs tinged by pomades may be detected by using alcohol or ether, which will dissolve out these preparations. If a prisoner's hair has been dyed, his scalp will often be found tinted. In a doubtful case the head might be shaved, and then carefully watched. The young hairs will, however, be somewhat lighter in tint than the old ones at first, and somewhat *darker* a little later. Hair resists putrefaction in a most wonderful manner, particularly if the soil be dry. Many mummies have most perfectly preserved hair.

Workers in copper may have copper oxide in their hair; and indigo, ebony, and other matters often adhere to the hairs of those working in them.

STAINS.

There are few things the medical jurist is called upon to examine more frequently than stains. Not a few cases might be cited where a verdict has in a great measure been decided upon the evidence of the nature of a stain.

SEMINAL STAINS.

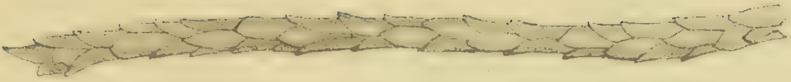
Seminal stains may be confounded with stains of albumen, such as from the white of an egg, or with stains resulting from any gummy material. In each case the fabric is stiffened; and if the stain be upon a white substance, it will scarcely show any colour. On carefully, however, comparing together different stains, and especially by transmitted, rather than by reflected light, it will be seen that a seminal stain has a slightly more marked greyish-brown tinge than stains produced by gum or albumen.

Caspar remarks that seminal stains are usually to be found at the *back* of the shift or other garment.

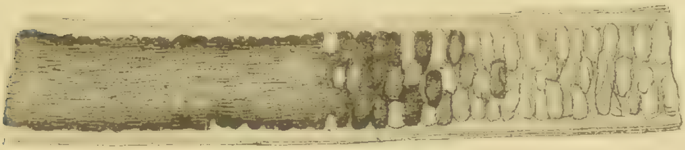
Tests for Seminal Stains.

A spot of semen may be known as follows:—

1. Warm the stain by holding it near the fire. It will become of



Hair of Seal. ×200



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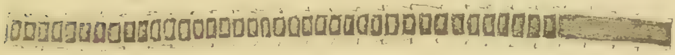
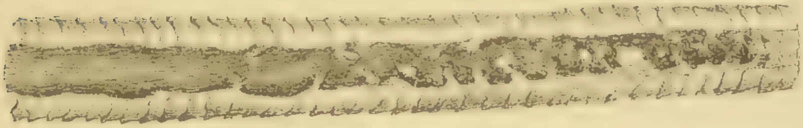
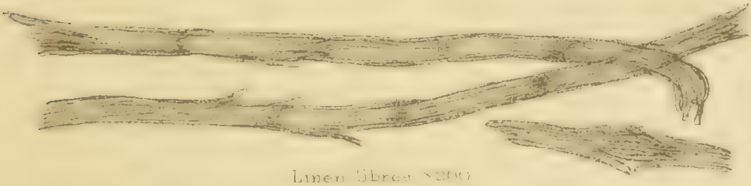


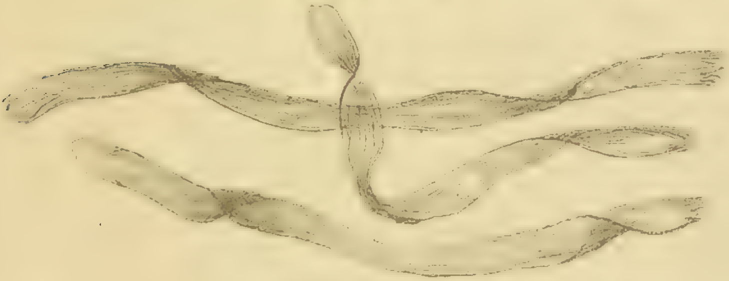
Hairs from Sable



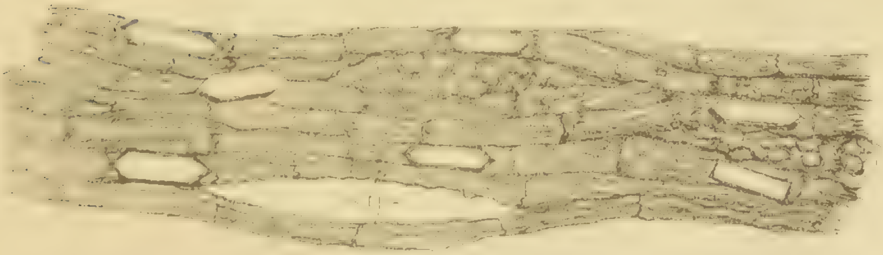
Sheep's Wool. ×200



Linen fibres ×200



Cotton fibres ×200



Fibres of Bast Matting
showing Raphides. ×200.

J. Needham del. E. Burgess lith. W. West & Co. imp.

a pale yellow tint if it be seminal. This is a very characteristic and conclusive reaction, happening with hardly any other discharge, healthy or unhealthy.

2. If a seminal stain be moistened with warm water, it will be found to evolve the odour peculiar to the seminal fluid.

3. Cut a portion of the stain out, and place it in a watch-glass, with five or six drops of water. Leave it for about ten minutes. Having removed the piece of the fabric, squeeze the water out with the fingers, or by means of a glass-rod, into the watch-glass. Place this in a good light on a piece of white paper, and add a drop of nitric acid upon a glass-rod, when, if the stain be seminal, the liquid will turn of a yellow colour, but no precipitate will be produced.

4. Lassaigne suggests that, in order to distinguish between an albumen and a semen stain, it should be moistened with a solution of oxide of lead in liquor potassæ, and dried at 68° F. If it be an albuminous stain (that is, if it contain sulphur), it turns of a yellow colour; but if it be seminal, no change is apparent, unless, as sometimes happens, the semen be diluted with some albuminous secretion.

5. In pure seminal stains the guaiacum test gives no blue reaction.

The above tests, however, are rendered practically worthless, if the garment on which the stains are found is dirty or coloured. Under such circumstances we must rely entirely on microscopic examination; and it is to be further noted that we should not be justified under any circumstances in pronouncing a stain to be seminal, unless the results of the microscopic examination were conclusive.

Microscopic Examination of a Seminal Stain.

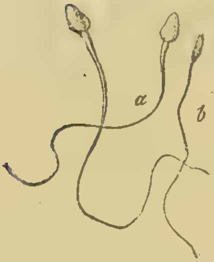
This consists in the search for the minute, but very characteristic, bodies, known as the seminal animalcules (spermatozoa, zoosperms), which exist in the semen of those who have arrived at puberty. We are aware, as Casper proved, that semen and stains of semen have been found and may exist without any spermatozoa being discoverable with the microscope; but we consider that it would be unwise to venture on giving evidence as to the seminal nature of a given stain, unless we were able to find, without doubt, remains of the seminal spermatozoa.

To Examine a Suspected Seminal Stain Microscopically.

Carefully, and with as little handling as possible, cut the stained portion out of the fabric. Place part of it in a perfectly clean watch-glass, with two or three drops at most either of cold distilled water, or of a 2 per cent. aqueous solution of salt or sugar. Other liquids are recommended by other authorities for the purpose. Grohe suggests the use of a solution of magenta, which colours the contents of the spermatozoa a deep red, whilst the use of a solution of ammonia is also recommended. We should advise using no other re-agent for acting on the stained cloth than pure water. Move the stained fabric about in the water with a piece of glass-rod drawn out to a blunt point. Having allowed it to soak for about ten minutes, squeeze the water out with the fingers, or with the end of the glass-rod, and examine several specimens of the liquid, and especially any deposits that may form, under the microscope, using for the purpose a quarter-inch power.

The microscopic appearance of the zoosperms is most characteristic (Fig. 46).

FIG. 46.



They are exceedingly minute bodies, their entire length often not being more than the $\frac{1}{600}$th of an inch. It is well to remember, however, that not only is there a great variation in their magnitude, but that there is an equal variation in their multitude. Hence you should never conclude the absence of spermatozoa until you have submitted several drops of the solution to examination.

The human spermatozoon has a flattened and almost oval head, with a long slender filamentous tail. The entire length varies, according to Mr. Curling, from the $\frac{1}{500}$th to the $\frac{1}{600}$th of an inch. Some, however, are to be found that do not exceed the $\frac{1}{1000}$th of an inch in length. The tail is usually five or six times the length of the head, which is about $\frac{1}{9000}$th inch in diameter, and may roughly be regarded as about one-third the size of a human red blood corpuscle. The shape varies in different animals.

FIG. 47.

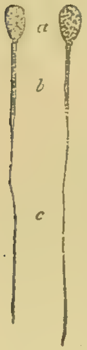


Fig. 47 represents the shape of the spermatozoa of the sheep, and Fig 48 those of several other animals. In fresh semen, as well as often in semen taken from a body some hours after death, and very frequently in semen for some hours after emission, the vibratile, undulating motion of the animalcule, principally executed with the tail, betokens life. A case is on record (in "Beale's Archives") in which spermatozoa were found, still capable of movement, in mucus taken from the vagina of a little girl fourteen days after the rape she had suffered. But even when they are dead, and the stain is dry, they are easily discovered and distinguished by their peculiar shape. We have more than once seen them in stains six months old; whilst some have asserted they have been able to discover them after five or six years (Ritter and Bayard). They have certainly a remarkable power of resisting putrefaction, having been observed by several microscopists in semen that had become putrid. Their movements, when alive, are not checked by admixture with other secretions. They are stimulated in their movements by alkalies, but arrested by weak acids. A temperature above 120° F., however, kills them in a very short time.

With what may these Seminal Animalcules be Confounded?

1. It is possible to mistake *minute fragments of linen fibre* washed out of the fabric under examination for the tails of the spermatozoa. Hence, it is a safe rule to admit nothing to be spermatozoa unless one or more complete spermatozoa are found. The characters of linen and cotton fibre, however, are sufficiently well-marked to prevent any possibililty of mistake by the careful observer (page 574).

2. *Granules* are to be found in all semen, which might be mistaken by a careless observer for the head of an animalcule. The

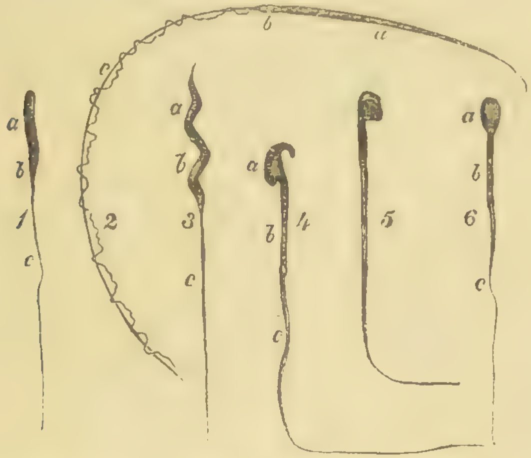
granules, however, are, as a rule, much larger than the heads; and, if the rule we have laid down be observed, of allowing nothing to be proof of the existence of spermatozoa unless the complete animalcule (head and tail) is found, these granules will prove no fallacy.

3. M. Donné discovered and described, in vaginal mucus, an animalcule, not unfrequently found where cleanliness is a secondary consideration, called by him "*Trichomonas Vaginæ.*"

Note these differences, however, between the trichomonas and the seminal animalcule. (*a*) The heads of the trichomonads are at least three times the size of the heads of spermatozoa. (*β*) Internally the trichomonads are granular, whereas the heads of the spermatozoa are perfectly transparent and structureless. (*γ*) From the boundary wall of the head of the trichomonads several ciliæ are apparent, whilst from the spermatozoon there are none.

4. Certain *fungi* are said very closely to resemble spermatozoa. Dr. Beale has figured some of them. In the fungi the apparent tail is much clumsier, they refract light differently, and they may be seen, under favourable conditions, to grow on the glass slide.

FIG. 48.



1. FROG—*a*, Head; *b*, Body; *c*. Tail. 2. Triton. 3. Finch. 4. Field Mouse. 5. Hedghog. 6. Sheep.

Lastly, we would say, under no circumstances admit a stain to be seminal, unless you discover *complete* spermatozoa. The other tests are to be regarded as strongly confirmatory, but not as primary, evidence. And further, the presence of complete spermatozoa leaves no doubt whatsoever but that the stain is seminal.

BLOOD STAINS.

When you are called to examine suspected blood stains, note in writing:—(1) their exact position on the garment or instrument; (2) if upon a fabric, the side of the fabric on which they occur; and (3) the number, size, and exact shape of the spot or spots. It is, moreover, advisable whether the stains be upon fabrics or upon instruments, such as knives, axes, hammers, &c., for the medical jurist to place upon such articles a private mark by which he may be able to recognise them readily in the witness-box as the articles submitted to examination, and upon which the stain or stains were found.

Naked-Eye Appearances of Blood Stains.

Considerable variety will be noted in the naked-eye appearances of blood stains. They may, of course, be mere smears, and without character; but more frequently they are found as small circular spots, having well-defined margins. Should the blood, however, have been splashed on the substance *obliquely*, the spot will then very probably assume a comet-shaped form; that is, an oval head with a long pointed tail, the extreme end of which is more or less bulbous. If the spots be upon a coloured substance of any kind, they are best distinguished by artificial light.

The colour of the stains will depend on various causes; such as (1) upon their age; (2) upon their thickness; (3) upon the amount of moisture and the temperature to which the blood has been subjected; and (4) upon the kind of material upon which it has fallen. If the stains be upon *polished* bodies, such as metals, they generally appear as dark shining spots, easy of removal, with cracks radiating from the centre. If upon cotton, silk, or linen, &c., they have usually a stiffened feel, like a spot of dried gum.

And now *examine the spots with a large magnifying glass.* By this means you may be able to discover clots or coagula, which, if the stains are upon fabrics, will be more or less mixed up with the fibres of the material. This is a strong argument in favour of the stain being blood, but you must not be satisfied without further examination. It is well to remember that there is a close similarity between clots and small particles of some substances, such as kino. Kino, however, may be easily distinguished by the greenish-black colour produced by the action of a persalt of iron upon it.

Physical and Chemical Properties of Blood.

We need say little respecting the identification of blood when in quantity. The spontaneously coagulable fibrin, the coagulability of the serum by heat and nitric acid, and the several tests we have now to describe, render the investigation under such circumstances perfectly simple. We may, however, note in passing, that Dr. Letheby has shown the almost perfect absence of fibrin in some samples of menstrual blood. The same has been noted in some cases of purpura hæmorrhagica.

Human blood is a reddish, viscid fluid, having a sp. gr., on an average, of 1055, varying in colour according as it flows from an artery or vein; in the former case, in health, it is of a bright red, and in the latter, of a darker or purple tint. The colour, however, chiefly depends (as will be shown under Spectroscopy), on the oxidation of the colouring matter of the corpuscles. Hence, in certain diseases, and in cases of suffocation, blood from an artery may be dark; whilst on the other hand, blood escaping very slowly from a vein, and becoming exposed to the air, is of a bright colour.

(*See* Wounds.) When venous blood is examined in thin layers, it exhibits what is called dichroism, or double colouration; for it is deep red or purple by reflected light, but assumes a greenish hue when examined by transmitted light. There is a peculiar odour of an animal kind, about blood which has been treated with sulphuric acid. Some experts claim that they can thus determine by their nose to what animal, and to which sex the blood belonged! Such nice discrimination is, to say the least, rare. In the living animal, the blood is made up of:—

Fibrin Albumen Salts	In solution, forming the liquor sanguinis.
Red and White Corpuscles.	In suspension in the above liquor.

But soon after death, or after its escape from the body, the blood coagulates or clots, and the arrangement in coagulated blood is as follows:—

Fibrin and Red and White Corpuscles.	Forming the crassamentum or clot; always entangling some serum in its meshes.
and	
Albumen and Salts.	Remain in solution and constitute the serum. The sp. g. of serum is about 1030.

The firmness of the coagulum or clot depends chiefly upon the amount of fibrin present, which varies somewhat in healthy people, and, as has been shown by M. Andral, varies still more in disease. In some kinds of purpura, scurvy, and putrid fevers, there is not only less fibrin than in health, but there is scarcely any at all, and the blood will hardly coagulate or clot. In other diseases of an inflammatory type (acute rheumatism, pneumonia, &c.) the quantity of fibrin may reach 10 or even 20 parts in 1000; the blood thus tends to coagulate whilst circulating, and often does so. (*See* Embolism, in any modern work on Medicine or Pathology.) In health, however, the average composition of human blood (the mean of many analyses), may be taken to be, in 1000 parts:—Water, 784; red corpuscles, 130; albumen of serum, 70; salts, 6; extractives and fat, including gases, 8; fibrin, 2. The principal salts found in the blood are chlorides of sodium and potassium, tribasic phosphate of soda, carbonate of soda, sulphate of soda, phosphates of lime and magnesia, oxide and phosphates of iron (0·05 of iron in 1000 parts). Playfair and Boeckmann have found that the blood of the ox (which closely approaches human blood in composition) is almost identical in per centage composition with the flesh, and may be represented by the formula $C_{45} H_{39} N_6 O_{15}$.

It has been said that the *firmness* of the clot mainly depends upon the amount of fibrin in the blood, the rule being, the more fibrin the firmer the clot. The same circumstance modifies the colour also, which mainly depends upon the rapidity with which the clotting takes place. If the clot form slowly (which is generally the case where there is much fibrin, as in inflammatory blood), the red corpuscles, whose sp. gr. is about 1088, sink to the bottom, and as the white corpuscles are less heavy, they are entangled in the clot, which by shrinking, acquires a cupped or concave surface, and assumes a *buffy coat* or colour. If it set rapidly, it will have more red corpuscles, and be less buffy. Coagulation of blood is hastened by the following circumstances :—

(1) A temperature of 100° to 120° F. (= 37·7° to 48·8° C.)

(2) Rest favourable but not essential; for coagulation is promoted by—

(3) Contact with foreign matters, especially multiplication of points of contact, as in beating blood with a whisk to coagulate it. For the same reason probably blood is found, after death, to coagulate quicker in the rough, uneven heart, than in the smooth arteries or veins.

As regards spots of blood from a wound, there will be more clotting on a rough canvas or woollen shirt, than on a smooth stone or deal floor.

(4) The ready and free access of air ; hence blood coagulates better

(5) In shallow vessels, or thin layers, than in deep or tall vessels, or in mass.

(6) The addition of rather less than twice its bulk of water favours coagulation.

(7) Venæsection is said to favour clotting, *i.e.*, the last blood which escapes clots more readily than the former. Attention to this may sometimes aid us in determining where a wound was inflicted, by careful examination of the blood-stains.

The Coagulation of the Blood is retarded—

(1) By cold. It is said that below 40° F. (4·4° C.) it will not coagulate at all. But frozen blood, if thawed, coagulates, though badly.

(2) A heat above 48·8° C., which either retards or by coagulating the albumen, prevents the formation of a clot.

(3) By the addition of more than twice its bulk of water.

(4) Contact with living tissues retards, but does not prevent coagulation (*teste* Aneurism, Embolism, &c.).

(5) By alkaline and earthy salts in 2 to 3 per cent. solutions, or stronger [especially the sulphate and chloride of sodium].

(6) By want of aëration, as in suffocation; also by a thin layer of oil or varnish on the surface.

(7) Certain inflammatory states retard coagulation, though the blood clots more firmly (see above).

The above excellent summary is chiefly taken from Mr. Morant Baker's "Kirke's Handbook of Physiology." As regards lightning and some other forms of sudden death, see the chapter on those subjects. See also page 23, for the remarks of Sir James Paget, as to the position of the red layer in the clot in the heart and blood-vessels after death as indicating the position of the body. The reticulated, or net-like appearance of some old blood-stains is chiefly, if not entirely, due to the coagulation of the fibrin. This has been pointed out (partly with reference to fossil blood of great antiquity) and figured by Dr. John W. Ogle ["Brit. and Foreign Med. Chir. Review," July, 1865, pp. 201 2]. This network, as has been shown by Neumann, differs with the blood of different animals, and in this way it is sometimes possible to tell the source of the blood. [See description and plates in "Die Erkennung des Blutes," von Adolph Neumann, Leipzig, 1869.]

Action of Cold Water on Blood Stains.

Let us here take particular note of the action of cold water on blood stains.

(*a*) If the stain be *of recent date* and upon *an inert substance*, that is, upon a body incapable of combining chemically with any of the blood constituents, it will be easily and rapidly dissolved when acted upon with cold water, the solution being of a rich red or of a brownish red colour.

(β) If the stain be *not fresh, but still comparatively recent*, it then assumes, more or less, according to its age, a brown tint, and is less easily and less rapidly dissolved by water, the solution not being red, but of a dirty brown colour.

(γ) If the stain *be very old*, it will then be greatly altered in appearance, and be perfectly insoluble in water, the soluble colouring matter being completely changed into an insoluble material (hæmatin).

Chemical Tests for Blood Stains.

All our tests for blood have special reference to the reactions of several reagents on the peculiar colouring matter of the blood.

1. (*a*) If the stain be upon *a fabric, such as cotton, linen, silk, &c.*, cut a portion of it out, and mix it with a little cold water, in a test tube.

   (β) If the stain be upon porous bodies, such as wood, bricks, &c., scrape off the stained portion for some depth, reduce it to a fine powder, and digest the powder for some hours in cold distilled water.

   In either case (*a* or β) filter the liquid, preserving both the matters on the filter-paper, as well as the filtrate, remembering that in some cases the blood-colouring matter may be present in a combined and insoluble form.

   (γ) If the stain be upon *iron or steel*, dry it thoroughly, when, possibly it will peel off, but if not, it must then be scraped. These scrapings will consist of a mixture of blood and iron. Digest them for a considerable time in cold distilled water, rendered slightly alkaline with ammonia; or, if this fails in effecting a solution, a trace of citric acid may be used. Now filter, when the blood-solution will pass through the paper, and the iron be left on the filter. It is well to remember that the colouring matter of blood is rapidly changed from the soluble into the insoluble form by the action of the hydrated oxide of iron. Hence a blood-stain on the *handle* of a knife or axe may present a very different appearance to one on the *blade*, though both were produced at the same time.

2. Divide the solution obtained from α, β or γ, into several parts, and test them by the several methods now to be described :—

A. To one portion in a test-tube add a drop of *a very weak solution of ammonia.* If the red liquid be blood, the colour will either remain unchanged, or if changed, be slightly intensified and reddened.

If too much ammonia be added, or the solution be too strong, the red liquid will become of a brown tint. But the red colour of blood is never changed either to *green* (as almost all the juices of red fruits would be), or to *crimson* (as is the case with the colour from cochineal, logwood, Brazil wood, madder-root, &c.).

B. *Heat another portion in a test-tube to about* 65° C. (149° F.). Note with a blood solution three results :—(1) The red colour is completely destroyed; (2) The solution is coagulated; (3) A thick brown precipitate is produced, the amount of which depends on the strength of the solution under examination.

C. If this brown precipitate be in sufficient quantity, collect it upon a filter, dry and heat with some weak ammonia, in which, if it be blood, it will be found soluble, the solution, if sufficiently strong, appearing dark green by reflected and red by transmitted light.

D. To another portion add *a drop of a solution of chlorine.* The colouring matter of blood will be found scarcely at all affected by the chlorine. A blood solution, it may be noted, further, is not easily bleached by *a solution of sulphurous acid.*

E. To another portion add some strong *nitric acid.* The red colouring matter of blood will be coagulated, and the solution become of a dirty brown colour. If the coagulated mass is in sufficient quantity, heat it with some strong nitric acid, when a clear yellow solution will be obtained.

F. A red precipitate is produced on the addition of a little *tincture of galls.* This reaction is important, as all red colouring matters due to iron yield a dark blue, or bluish green precipitate.

3. Blood stains are insoluble either in strong alcohol, ether, chloroform, or oils.

Stains Likely to be Mistaken for Blood-Stains by the Naked Eye.

1. *Madder mixed with Albumen* (suggested by Raspail).—The colour in this case is not destroyed by heat, whereas that of blood is. On the addition of a solution of alum, it is changed yellow; whereas the red colour in a blood-solution will be merely diluted.

2. *Sanguinaria.*—The red colour is decolourized by ammonia.

3. *Brazil Wood.*—The red colour is turned crimson by ammonia.

4. *Logwood.* — The solution is reddened by sulphuric acid, and blackened by sulphate of iron.

5. *Camwood and Red Saunders.*—These colours are insoluble in cold water, and very soluble in alcohol and ether. They are both turned crimson by ammonia.

6. *Archil, fruit stains, flower stains* are all turned either blue or green by the action of ammonia.

7. *Sulphocyanide of Iron.*—The red colour is destroyed by ammonia.

8. *Citrate of Iron.*—The colour is soluble in water, and remains unchanged by the action of ammonia. It is decomposed by sulphuric acid, and answers to the general tests for iron.

9. *Anatto.*—The colour is soluble in water, and is not changed by the action of ammonia. It turns dark blue on the addition either of sulphuric or of nitric acids.

10. *Catechu* (*Cutch*), *Rhatany, and Kino.*—These bodies are soluble in water, but are not altered by the action of ammonia. All three contain tannin. The two first become black, and the third a greenish black, on the addition of a salt of iron.

11. *Iron Moulds, or Red Paint made from Iron.*—These are not soluble in cold water, but they are soluble in hydrochloric acid. (Care must be taken that the acid itself is free from iron.) This solution gives a characteristic dark blue with *ferrocyanide of potassium*, and a bright red with *sulphocyanide of potassium*, provided there is no great excess of acid. In cases where a stain is believed to be due to an iron-mould, you should always examine the dye of the fabric, to prove the absence, or the presence, as may be, of iron in the dye.

12. *Spots of Rust on Steel Instruments.*—The rust spot is insoluble in water. Thoroughly act on the spot with distilled water and filter; the solution, if rust, will be uncoloured. If there is any precipitate on the filter-paper, it will probably be soluble in dilute hydrochloric acid. (Do not act on the blade with hydrochloric acid, but merely with pure water.) The hydrochloric acid filtrate can then be proved to contain iron by the ferrocyanide, and by sulphocyanide of potassium.

13. *Spots of Lemon or Orange Juice on Steel.*—In this case a citrate of iron is formed, which is soluble in cold water, forming a light-coloured yellow tinted solution, having an acid reaction. The colour is unchanged by the action of ammonia, or by boiling. It is known to be an iron salt by the tests described. (*See* 8 and 11, above.)

14. *Stains of grease* on dark fabrics, and *spots of pitch and tar* on the clothing of sailors, riggers, and others, who have to handle these materials, have been mistaken for blood by those unfamiliar with the subject. The use of a pocket-lens will usually distinguish these from blood-stains; but the former (*i. e.* grease-stains) may be easily detected by putting a bit of white blotting-paper over the stain, and pressing a hot iron over it, and also by their ready solubility in ether, benzol, and chloroform. The latter (tar and pitch) have an odour *sui generis* when warmed, and are readily soluble in turpentine, or alcohol, neither of which solvents have much effect on blood-stains.

In all these fourteen cases the microscope will prove the absence of blood corpuscles in the stain.

Spectroscopic Test.

There are no tests for blood, however, upon which the skilful manipulator may rely with more absolute certainty than upon the different spectra produced by the blood-colouring matters.

History of the Spectroscopic Test.

The black bands of the solar spectrum, discovered by Wollaston in 1805, and rediscovered by Fraünhofer in 1815, were proved by Kirchhoff, in 1859, to be due to certain gases and vapours in the solar atmosphere, having a power, peculiar to themselves, of absorbing definite parts of the spectrum, the rays which the gas or the vapour absorb, being the very rays that the body producing the gas emits. Similarly certain coloured solutions were found to possess a like power to gases of absorbing definite portions of the spectrum. Just as the knowing the portion of the spectrum that a given gas absorbs becomes a test for that gas, so in the case of liquids, the discovery of certain absorption-bands, known to be peculiar to a given body when in solution, becomes a test for that body. Blood in this respect is very remarkable, its absorption-bands proving a method of analytical investigation far more delicate and certain than all chemical tests. The peculiar spectra of blood were first noticed by Hoppe in 1862, and were suggested by him as a means of medico-legal research. Stokes, in 1864, and Sorby and Letheby since, have added largely to our knowledge of the subject.

The Colouring Matter of Blood.

It will be advisable before describing in detail the various spectra of blood; to examine the chemistry of the colouring-matter, it being the active agent in producing the distinctive bands. It is most important further to understand the changes that this colouring-matter undergoes by keeping, inasmuch as the alterations brought about by time, furnish us with most important evidence, necessitating, moreover, different methods of working, depending on the changes thus effected.

The colouring-matter of blood was, in the first instance, described by Lecanu, and named by him *hæmatin ;* but Professor Stokes proved that the hæmatin, described by Lecanu, was a different body to the colouring-matter contained in fresh blood. Stokes named this colouring-matter of fresh blood *cruorine,* and proved that it was capable of existing in two states of oxidation. *The deoxidized form* (such as is present in venous blood) he called *purple cruorine ; the oxidized form* (such as is present in arterial blood) he called *scarlet cruorine.* The spectra obtained from these two varieties of cruorine were found to be very dissimilar. His experiments, moreover, suggested that the colouring-matter of the blood was intimately concerned with the phenomena of respiration, owing to the remarkable facility it possessed both of absorbing and emitting oxygen. This cruorine we now called *hæmoglobin,* which term for the future we shall employ. It is perfectly soluble in water ; and, according to W. Preyer, nearly the whole of the iron in the blood is contained in it as an essential ingredient.

There are some reasons for believing that there is an essential difference in the hæmoglobin of the blood of different species of mammalia, the crystals of the body obtained from different animals, varying much in their solubility as well as in their crystalline form (" Blut Krystalle," W. Preyer, Jena, 1871). But of this at present we know very little for certain.

We must now examine the products of the decomposition of hæmoglobin. If the dry blood-stain be exposed for a time to the air, a new substance of an albuminous nature is produced, originally called by Sorby *Brown Cruorine,* but now generally known as *Methæmoglobin.* This substance seems to occupy an intermediate position between hæmoglobin and the hæmatin of Lecanu. By the action of reagents, such as acetic, tartaric, and citric acids, &c. (but not, it should be noted, by the action of hydrocyanic acid), the *bright red* of fresh blood becomes changed in colour to a *brownish red.* The *hæmoglobin* has thus become, in fact, Lecanu's *hæmatin.* The change is chemical and permanent; for you cannot restore it to the original condition by neutralizing with an alkali. The same change of the hæmoglobin into hæmatin takes place when the blood has been kept for a long time. The fresh blood-stain is bright red (hæmoglobin); the old stain is brown (hæmatin). This hæmatin, whether produced by age, or by the action of acids, is, like hæmoglobin, capable also of existing in two states of oxidation, each state having its own special spectrum-bands.

Changes in the Colour of Blood Stains.

It will be well here, briefly, to consider the changes produced on a blood-stain by time, as well as by various other circumstances, capable of effecting alterations.

The blood-stain, when fresh (if upon a white fabric), has a bright red colour. The colouring-matter is *hæmoglobin* ($C_{600}\ H_{960}\ N_{154}\ Fe\ S_3\ O_{179}$).

If the stain be kept in a very damp place, the hæmoglobin is rapidly changed into *hæmatin,* or both hæmoglobin and hæmatin, may be decomposed.

But if the stain be kept dry, it becomes in time of a brown colour. This colouring-matter is *methæmoglobin.* Sorby regards this body as hæmoglobin, loosely combined with an extra supply of oxygen (peroxidized hæmoglobin). This change from hæmoglobin into methæmoglobin varies according to circumstances. Mr. Sorby found that in the centre of the town of Sheffield, for example, the change was brought about after a few hours, whilst at a distance of six miles from the town, and away from houses, it required at least a week to produce any appreciable alteration. Further, the time necessary to bring about the change is much influenced by keeping the stained material indoors; and, again, the alteration is rendered very much more rapid by its exposure to an atmosphere in which coal gas is being burnt, the presence of a very minute trace of sulphurous, or other weak acid, tending very greatly to accelerate it. Again, the change is very rapid when the stained fabric has been, or is worn next the skin, the alteration in this case being hastened by the action of the weak acids of the perspiration.

This rule is a safe one; *if the colour of the blood-stain be bright red, it is a proof that the stain is recent; but if it be brown, it is no proof that it is old.*

After a long, but variable period, the whole of the colouring-matter will become converted into *hæmatin* ($C_{68}\ H_{70}\ N_8\ Fe_2\ O_{10}$).

The Spectra Produced by Blood.

Let us now examine the peculiarities of the several spectra produced by the colouring-matter in the various states we have described. (*See* Plate V.)

(1) Represents the solar spectrum, the position of a few of Fräunhofer's lines being marked.

(2) *The spectrum of scarlet or oxidized hæmoglobin,* the colouring-matter of arterial blood.
Characters of spectrum.—The blue end is darkened. Two absorption-bands are visible just below Fräunhofer's line D in the yellower half of the green. The band nearer the violet end is about twice as broad as the other band.

(3) *The spectrum of purple or deoxidized hæmoglobin,* the colouring-matter of venous blood.
Characters of spectrum.—The blue end darkened, but somewhat less so than in the previous case, a single broad absorption-band being visible in the green.

(4) *The spectrum of blood after a short exposure to air.*
Characters of spectrum.—The blue end appears darkened. The two bands of oxidized hæmoglobin are much weakened, whilst a third band is visible in the red.

(5) *The spectrum of blood after prolonged exposure.*
Characters of spectrum.—The blue end is much darkened. The band in the red is much more intense, whilst the bands in the green are less so.

(6) *The spectrum of blood after prolonged exposure,* with the addition of a little ammonia.
Characters of spectrum.—The band in the red disappears, whilst the bands in the green are strengthened.

(7) *The spectrum of acid hæmatin.*
Characters of spectrum. — The blue end appears much darkened. A very broad band will be found in the red, a second band in the green, whilst a third exceedingly faint band may be occasionally seen in the blue.

(8) *The spectrum of reduced or deoxidized hæmatin.*
Characters of spectrum.—The blue end is darkened. Two well-defined bands are seen in the green, but somewhat nearer the violet than those of oxidized hæmoglobin. The band nearer the red is the narrower, but it is intensely black, and has exceedingly well-defined edges. The lower band (that nearest the violet) is nearly double the width of the other band, but the edges are somewhat less distinct. This band possibly may not be seen in a very weak solution.

Let us now proceed to consider:—(1.) The instruments with which these spectrum investigations are to be conducted; and (2) The various methods to be pursued under different circumstances in the investigation.

Apparatus for Micro-Spectroscopic Analysis.

The instrument usually employed is that suggested by Mr. Sorby (Fig. 49). It consists of prisms (P) arranged for direct vision contained in a tube (Fig. 50), capable of being removed at pleasure. For examining blood spectra, prisms are to be preferred with a much lower dispersive power than those ordinarily used for examining incandescent gases. For accurate work, it is advisable to have several eye-pieces, containing prisms of different degrees of dispersion; but we are convinced that a comparatively slight dispersion is that best suited for blood analysis, as well as for the examination generally of organic colouring-matters.

FIG. 49.

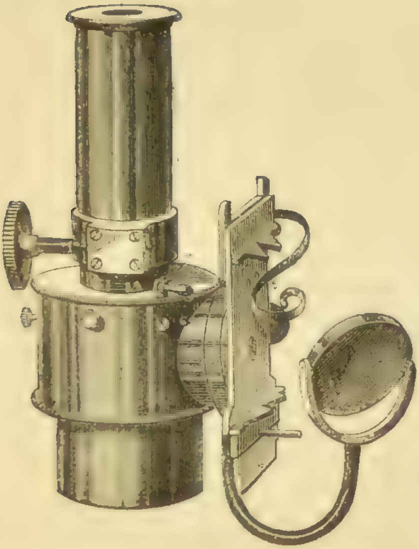
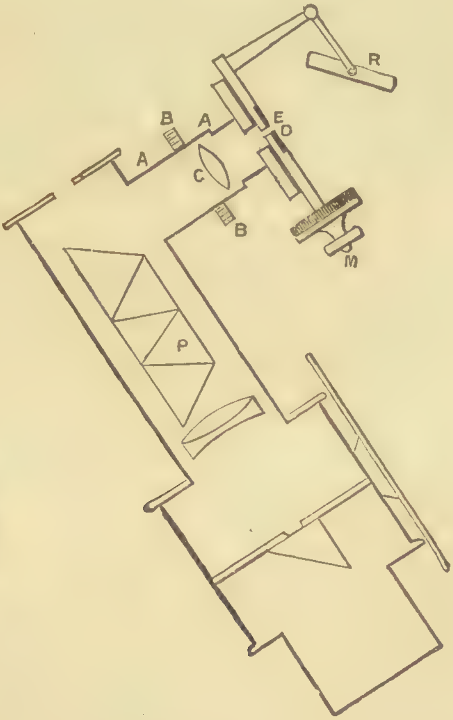


FIG. 50.



Below the prisms is an achromatic lens, the focus of which can be adjusted by rack-work. The width of the slit is regulated by turning a fine screw, so that the best effect may be obtained during the examination of the solution. It is absolutely necessary in these investigations that we should be able to compare spectra—say a spectrum of a known with an unknown body, side by side; and for this purpose the instrument is provided with a stage having an adjustable slit, so that a second spectrum may be obtained. The production of this second spectrum is effected by a right-angled prism, so contrived that the light may be reflected through half the main slit. Below this is the field-lens of the eye-piece. The instrument fits on the microscope, like an ordinary eye-piece. As a rule we use a low power, so as to get plenty of light. The object to be examined is placed on the ordinary microscope stage, and illuminated, if transparent (as blood is), by the stage-mirror, supplemented in some cases with a condensing-lens. It is advisable in working with the micro-spectroscope to use a very steady binocular microscope, so that the tube not in use for the spectroscope may be employed for adjusting the object. It is well to notice that each part of the spectrum, differing as it does a little in refrangibility, may need accurate focussing, if delicate bands or lines are to be seen perfectly.

This form of apparatus has very recently been in many respects much improved by Mr. Sorby, aided by the practical skill of Messrs. R. and J. Beck, the eminent microscope makers. The micro-spectroscope constructed by them fits on to the microscope, not at the eye-piece, but where the object-glass is ordinarily placed. We strongly recommend this form of spectroscope. The management of the light is much more simple, whilst there is no difficulty, as there is with the other form of apparatus, in obtaining two similarly illuminated spectra.

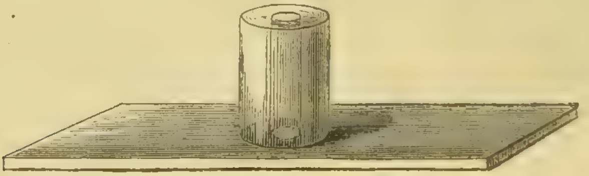
We purposely abstain here from giving any description of the various methods that have been suggested for measuring the position of bands, believing most strongly that in all medico-legal investigations we should not rely on such methods of measurement, but on comparison spectra, or, in other words, in comparing the unknown solution side by side with a known one.

And now let us proceed to consider the methods to be pursued in the examination of blood-stains with the spectrum microscope.

Examination of a Recent or Comparatively Recent Blood Stain on a White Fabric.

If you can detach a portion of the blood do so; but if this is impossible, cut out a small piece of the stained fabric, and soak it for about ten minutes in a few drops of cold distilled water in a watch-glass. Then squeeze the coloured fluid out, and stand it on one side for a short time, so that any insoluble matters may be deposited. After this introduce the solution with a fine-drawn pipette into a small glass-cell (Fig. 51), made of barometer-tubing, about half an inch in length, and having an internal diameter of about the one-eighth of an inch. One end of the cell is to be carefully cemented with purified gutta-percha upon an ordinary microscope slide. "It is a great advantage," says Mr. Sorby, "to insert between the plate and the cell a diaphragm of platinum-foil, having in it a circular hole about two-thirds the internal

FIG. 51.



diameter of the tube, and fixed, so that its centre may correspond to that of the cell. This prevents any light that has not penetrated through the whole length of the solution passing upwards, which is very important when using direct concentrated sunlight to penetrate through turbid or very opaque liquids." It is well to fill several tubes, if you have sufficient, with the blood-solution. Proceed now as follows :—

I. Allow one of the tubes to remain for a few minutes in a horizontal position, so that all suspended matters may subside, and the field of vision in this way, not be obscured. Place the tube on the microscope stage, and, after arranging its position accurately, carefully focus the top, or a little under the top, of the liquid. If the blood be tolerably fresh, the spectrum of oxidized hæmoglobin (Plate V. 2) with its two well-defined absorption bands in the green will be apparent. If such a spectrum be obtained, you are in a position to say that the stain is tolerably recent. But if you obtain the spectra indicated in 4 and 5 with its fainter bands in the green, and the extra band in the red, it indicates that the stain has undergone a change. Be careful in such a case not to fix any age whatsoever to the stain, inasmuch as the changes the blood has undergone are, as we have already pointed out, largely influenced by different circumstances. If you obtain spectra 4 and 5, add a trace of ammonia to the solution in the tube, stirring it in with the platinum wire, when you will obtain spectrum 6.

II. To a second tube of the suspected solution add, first, a very little *ammonia*, and then a small quantity of the double *tartrate of potash and soda* (Rochelle salt). This is found to be a most convenient reagent in preventing the precipitation of oxide of iron in solutions containing free ammonia. With this no change will be produced in the spectrum, the ordinary bands being visible as before. Now add to the liquid in the cell a piece (say about the 1-40th of an inch) of the double *sulphate of protoxide of iron and ammonia ;* stir the solution slightly with a piece of platinum wire, so as to mix the iron salt thoroughly, but with as little exposure to air as possible. Now cover the cell over with a piece of thin glass. The two bands seen previously will now have disappeared, and will be replaced by a single intermediate band, fainter but broader than either of the other two. This is the spectrum of reduced hæmoglobin (3).

The specimens of hæmoglobin thus reduced, may be again and again oxidized by exposure to air and by vigorous stirring with the platinum wire. They can then be again deoxidized by a further addition of the iron salt.

This deoxidization and reoxidization of the hæmoglobin is a very characteristic reaction, and serves to distinguish blood from most other substances.

Mr. Sorby originally used for this experiment ammonia and protosulphate of iron. The reagents we have previously mentioned are, however, in every respect infinitely preferable.

If a solution of blood be merely covered with a thin piece of glass, and kept for some time in the cell, the reduction of the hæmoglobin will be effected spontaneously, and without the addition of any reagents.

A question here may possibly arise whether this spectrum can possibly be due to the iron? The question is at once answered by the fact that other bodies, such as protochloride of tin, hydrosulphate of ammonia, or indeed any deoxidizing agent, will effect the same action as the iron salt, only somewhat more slowly.

III. Add to the suspected liquid in a glass cell a minute fragment of *citric acid*, stirring thoroughly with a platinum wire. (For purposes of convenience it is well to have the platinum wire flattened at one end, and turned up square in the shape of a small hoe (Fig. 52).

FIG. 52.

The acid will change the hæmoglobin into hæmatin. If, previously to the addition of the citric acid, the bands of the oxidized hæmoglobin were visible (Plate V. 2), they will now disappear; whilst, if the solution be tolerably strong, a faint band will be visible in the red. Add now an excess of ammonia. This is best done by dipping the platinum wire into the ammonia solution, and stirring the moistened wire immediately into the liquid in the cell containing the fluid. The band in the red, if present, will now disappear, the original bands either not being at all restored, or only restored to a very slight extent. This is a most important change to note, since it shows that the acid has effected a permanent change in the original blood-colouring matter. Add now to the solution in the cell a very small particle of the double sulphate of iron and ammonia, and cover the liquid over immediately with a piece of thin covering glass. Remove the excess of the liquid with blotting-paper, and, in order to exclude air, it is advisable to fix the glass cover on the cell with gold size. Turn the cell over and over, again and again, for a few minutes. In cold weather the process of deoxidation is slow, and even a quarter of an hour may elapse before it is complete. By this means the hæmatin will be reduced, and the excessively well-marked spectrum, perfectly unique under the circumstances (Plate V. 8), will be seen, having two bands, the one at the red end being the first to appear. If the solution be very turbid, the precipitate may be allowed to collect on the side by keeping the tube for a short time in a horizontal position. Preserve and mark the specimen for further examination, if necessary.

By exposing this solution of deoxidized hæmatin to the air, assisted by vigorous stirring, we may often succeed not only in bringing back again the oxidized hæmatin band, but also the bands of oxidized hæmoglobin.

IV. Lastly, add to some of the liquid under examination a small quantity of *boric acid.* If the solution be blood, no immediate change will be observed in the position of the bands.

Some of the above spectra may be obtained by merely drying a little of the blood solution on a piece of flat glass, and examining the dried spot with the spectroscope, the light being transmitted through the dried spot. We do not, however, advise this method of investigation.

The process we have now described is that applicable to recent, or to comparatively recent stains, occurring either upon articles generally, or upon white fabrics, or upon fabrics where there is but little colouring-matter. It will, however, need modification under certain circumstances, and these we must now consider.

Examination of Old Blood Stains, and of Blood Stains on Coloured Fabrics.

If the blood-stain be *old*, the colouring matter will probably be found to be scarcely at all acted on with cold water. Either citric acid or ammonia must then be used for dissolving it. If the fabric be a white one, ammonia should be employed in preference to citric acid; but if it be coloured, test first of all which of these two reagents has the least action on the dye colouring-matter, and use that one for the purpose of dissolving the blood which acts least on the colour of the cloth. To determine this, all that is necessary is to place a little piece of the fabric in two watch-glasses, and to act on the one with a little ammonia, and on the other with a little citric acid solution. There can be little doubt that ammonia should, if possible, be used in preference to the acid; but in the case of red fabrics generally, ammonia will be found to dissolve so much of the dye-stuff that the after-investigations with the coloured solution are rendered infinitely more troublesome and complicated. Hence, if the stain be found on scarlet cloth or on other red material, citric acid should be used as the blood solvent. Further, if the stain be found insoluble both in ammonia and in citric acid, then it should first of all be acted upon with ammonia solution, and a moderate heat afterwards applied. Proceed then with the solutions in the manner already described, examining them with the spectroscope both before and after deoxidation with the iron salt.

The age of a stain is no impediment to the spectroscopic test. No doubt hæmatin, although a very permanent body, does undergo certain changes by age, which changes at present are but ill understood. They are not, however, of any great practical moment, inasmuch as Mr. Sorby states he has been able to discover hæmatin with the spectroscope after forty-four years; whilst Dr. Letheby and one of the authors have obtained all the reactions from stains at least thirty years old.

The presence of mordants on various materials may necessitate an occasional alteration in our proceedings. More particularly this will be the case if the stained fabric has been afterwards wetted, and the blood by this means to a great extent removed. What blood remains on the cloth is then very likely to be incorporated with the mordant. In such cases a process such as the following should be adopted:—Digest a portion of the stained cloth in dilute ammonia, and afterwards squeeze out the liquid. Deoxidize *the thick, turbid, unfiltered solution* in the ordinary manner, and examine it for the deoxidized hæmatin bands, using concentrated sunlight, or the limelight if necessary. It is to be remembered that in the case we are supposing, the hæmatin is probably chemically combined with the mordant; hence filtration, or the allowing the deposit to subside, is equivalent to removing most of the blood colouring-matter, and so losing the spectra. The turbidity of the liquid must be overcome in such cases, not by removing the deposit, but by increasing the intensity of the transmitted light.

Examination of Stained Fabrics that have been washed after staining, and the treatment to be adopted in the examination of the Water that was used for washing them.

Hæmatin is a very insoluble body. Probably, therefore, after an article stained with blood has been washed in water, provided a sufficient time has elapsed for the change of the blood colouring-matter into hæmatin to be effected, enough will be left on the stained cloth to produce the spectra necessary for its identification. But it must be remembered that if the stain be perfectly recent, that is, before any of the hæmoglobin is converted into hæmatin, the whole of the blood may then be washed out by rinsing in cold water, and no trace be afterwards found on the stained material. Hot water will not effect this removal of the blood like cold water, owing to its further action. Hence, if in a criminal case there is proof that an article has been washed in *cold water*, evidence as to the absence of blood-stains is of little value; whilst if, after staining, the article was washed in *hot water*, the probability is there will be no difficulty in satisfactorily proving the real character of the stain. In many cases, after a stained fabric has been washed, the blood-stain will be found spread over a considerable surface. Under such circumstances a large piece must be cut out, and digested with a proportionately large quantity of ammonia, or of citric acid solution, concentrating the liquid afterwards by evaporation at a gentle heat.

The water used for washing such materials may have to be examined. This can be done by concentrating the liquid, if necessary, and examining it in the usual manner. If, however, it is found that there is any deposit in the water, it should be carefully collected, acted on with ammonia, and heat applied if the blood be insoluble in the cold solution.

If the recently-stained fabric, however, be washed *with soap-and-water*, hæmoglobin will be rapidly converted, by the action of the alkali, into hæmatin. Soap-and-water, therefore, really sets the stain, and the probability is that, after washing, there will be little difficulty in detecting it on the fabric itself by the ordinary means. It may be necessary sometimes to examine the soap-and-water, to see if it contains blood. This may be done as follows:—Agitate the soap-and-water with ether, and allow the mixture to stand until the ether has completely separated. Remove the ether with a pipette, and again and again shake the liquid up with ether until the aqueous solution is perfectly clear, and free from soap. This liquid must then be concentrated, and examined, as usual, for blood.

Examination of Stains on Leather.

Blood-stains on leather, or upon any body containing tannic acid, require special management from the precipitation of the colouring-matter, which is certain, more or less, to result. Proceed as follows:—

(*a*) Cut off a fine shaving from the stained portion of the leather, so that there may be as much blood, and as little leather as possible, on the shaving. Bend this shaving so that the side that is stained may be brought into contact with a little water placed in one of the experimental cells, whilst the leather side of the shaving is not wetted. In this manner, solution of the blood will probably be effected, and enough colouring-matter obtained for experiment.

Mr. Sorby points out, however, that when a drop of blood falls on leather, the serum soaks into the leather, and leaves the blood-corpuscles on the surface. If the leather be then washed, it would probably be impossible to obtain the blood-spectra by the method just described. The following process is then recommended by Mr. Sorby, which the authors have found to work satisfactorily:

(β) Digest for a considerable time a portion of the stained leather in a mixture of one part (by measure) of hydrochloric acid and 50 of water. This will effect a solution of the mixed compound of the blood colouring-matter and tannic acid. Pour the acid liquid off, but do not filter it. The solution may appear almost colourless, or of a slightly yellow tint. Add to this an excess of ammonia, when the colour will become either a pale purple or a neutral tint, the tint shade being considerably intensified on the addition of the ferrous salt and double tartrate, which are now to be added. The solution is then to be examined in an experimental cell, using a sufficiently intense light, such as the lime-light or direct sunlight, to penetrate the turbid solution. Under these circumstances, the spectrum of deoxidized hæmatin will be seen. If the liquid be too turbid to allow even a direct ray from the sun to be reflected through it, allow the cell to remain for a few minutes in a horizontal position, so that a little of the deposit may subside, although, if this can possibly be avoided, it is desirable to do so, because it will be found that the removal of the deposit at the same time destroys the intensity of the spectrum, proving that the greater part of the hæmatin under these circumstances exists as a compound, insoluble in dilute acid. Before commencing the experiment with the stained portion of the leather, it is advisable to make out clearly how large a piece of the unstained leather may be treated with a given quantity of the acid without producing too dark a solution, and to take care afterwards not to employ a larger piece of the stained portion of the leather than is justified by these trial experiments.

Examination of Blood Stains on Earth and on Clothes soiled with Earthy Matters.

The stained earth is to be carefully collected and digested in a considerable quantity of ammonia. This is to be poured off, concentrated by evaporation, and the spectroscopic experiments conducted as usual on the turbid solution, using an intense light, such as the lime-light or direct sun-light for the purpose, in the manner already described. A similar process should be adopted in examining stained fabrics soiled with earthy matters. This is important to note, inasmuch as the colouring-matter in a solution of blood will be found to be completely carried down by earthy matter when shaken up with it.

Examination of the Urine for Blood.

The urine, if turbid, should be filtered, care being taken that the matters on the filter paper are afterwards thoroughly washed with cold distilled water, otherwise red corpuscles may be lost. Either examine this latter filtrate by itself, or else add it to the filtered urine. The urine should then be placed in a glass tube six inches long, having an internal diameter of about a quarter of an inch, and closed at both ends with little pieces of white glass. The liquid is then to be diluted until the green of the spectrum is distinctly seen by the micro-spectroscope. One drop of blood in a pint of urine can in this way be easily recognised.

Substances producing Spectra likely to be mistaken for Blood.

It may here be asked, do no other substances give similar spectra to those of blood? Of the oxidized hæmoglobin spectrum Sorby says, "I do not know of anything that gives exactly the same, but there are some things which give bands so far similar as to show the importance of studying the effects of the different reagents." It may be well to give an instance or two.

The colouring-matter of the petals of the red variety of *Cineraria*, a variety of chlorophyll, gives two bands which, though perfectly dissimilar in relative width, are similar in position to those of oxidized hæmoglobin. But there can be no mistake after you have added ammonia, the bands in blood remaining unchanged, whilst those of the *Cineraria* solution are completely altered.

Again, a solution of *cochineal in alum* produces two bands somewhat like those of blood, though easily distinguished by the practised eye. Now add ammonia. In both cases the bands are rendered more intense. Add now excess of boric acid. With cochineal the bands immediately shift to the blue end of the spectrum, whilst with blood they remain unchanged.

The other reds likely to be confounded by the unpractised eye with blood are *lac-dye, alkanet, madder red, and munjeet*, dissolved in each case *in alum*. But it will be at once apparent, if the spectra be carefully examined side by side with blood, that the bands produced by these bodies are not the same either in position or in character. None of them, further, will stand the action of ammonia, whilst they are all bleached with sulphite of potash, which has no action on blood.

In the examination of *a mixture of magenta and blood*, the magenta bands may be found entirely to mask those produced by the blood. The various blood spectra may, however, be easily obtained unmixed, by adding to the solution a trace of sulphite of soda, which completely removes the magenta colouring-matter, but leaves the blood untouched.

All the supposed fallacies, however, at once break down if we successively obtain the various blood spectra with the several reagents as already described.

General Precautions to be observed in conducting Micro-Spectroscopic Observations.

We now add a few words of general advice and a few precautions necessary to be observed in examining blood-stains by the spectroscope.

1. If the fabric on which the blood-stain occurs be coloured, always examine the spectrum produced by the colouring-matter alone, taken

from unstained portions of the fabric. Further, it is well to put a little blood on an unstained portion, and, when dry, to examine its spectra, and thus fully determine, before commencing experiments on the stained portion, any possible interference in the blood spectra resulting from the presence of such colouring-matter.

2. On no account decide that an observed spectrum from a suspected stain is due to blood, unless it *exactly* coincides with bands produced by a known solution of blood of equal strength treated in a similar manner, and examined side by side. It is advisable to have several tubes of deoxidized hæmatin, of different strengths for purposes of comparison. They are best kept in hermetically-sealed tubes so as to be in readiness whenever they are needed.

3. In all cases examine the spectra both by daylight and by artificial light. We prefer artificial light for general work, but in every case it is advisable to try both means of illumination. Direct concentrated sunlight, or the lime-light, should be tried whenever the solution is thick and turbid.

4. Never be content with observing a single spectrum of blood. Remember, further, it is often impossible to obtain the unaltered blood spectrum. Hence, never satisfy yourself that a stain is not blood until you have failed to obtain all the spectra produced by the action of appropriate reagents.

5. If the liquid under examination be *too strong*, too much light will be cut off by the solution, and the absorption bands be in this way obscured. If the solution be *too weak*, the bands will be too faint, and so likely to be overlooked. Practise in this matter to obtain the happy medium. Never (if possible) be satisfied with a single examination.

6. Use excessively minute quantities of the several reagents. Hæmatin produced by an acid is not very soluble in a strong solution of citrate of ammonia. If you add too much protosulphate of iron, the precipitate produced so obscures the field as to mask the absorption bands.

7. Adjust the width of the slit during the spectroscopic examination. All absorption bands are best defined when the slit is very narrow, whilst, if the bands are very faint, they will often be best seen at the very moment that the slit is being completely closed.

8. Remember that, with our present knowledge, the spectrum microscope affords no information whatsoever as to whether the blood is from man or beast, nor from what class of animals it is derived; nor, if human, does it enable us even to hazard a conjecture as to the locality of its origin.

9. Lastly, unless the stain is bright red—an appearance which can only be noted on white or nearly colourless fabrics—never venture an opinion as to the probable age of the stain.

Of the certainty of this method of research, Mr. Sorby says ("Medical Press and Circular," May 31, 1871), "I unhesitatingly say we can distinguish blood" (*by the micro-spectroscope*) "from all other animal and vegetable colouring-matters." Dr. Letheby says, "There are no real fallacies to the test." Our own somewhat extensive experiments confirm the opinions expressed by these investigators.

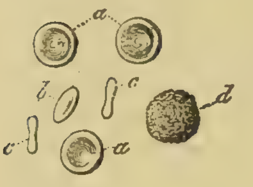
MICROSCOPIC TEST.

Microscopic Characters of Blood-Corpuscles.

We now proceed to investigate the microscopic characters of blood, and the application of the microscope to blood analysis.

The red blood-corpuscle (Fig. 53) is a nearly transparent cellular body, of a slightly yellowish tint, flattened in shape, having a distinctly circular outline. Its appearance differs largely with the light, the focus, and the objective employed. Generally, the blood-corpuscles appear as discs, having concave sides and a central bright spot which, by a slight change of focus, will appear shaded. We should advise, however, in medico-legal cases that all suspected microscopic specimens should be examined by comparison with known blood-corpuscles placed under exactly similar conditions of light, &c. If the red corpuscles be treated with water, they will be found to swell up, and ultimately burst, whilst they will shrink by the action of a strong syrup. They are dissolved by a weak solution of ammonia.

IG. 53.

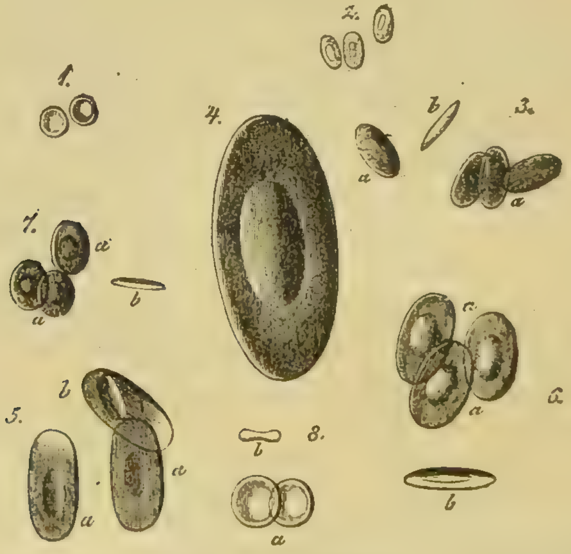


HUMAN BLOOD CORPUSCLES:—*a to c* = Blood. *d* = Colourless, or so-called Lymph Corpuscle.

Differences in the Blood-Corpuscles of different Animals.

The diagram (Fig. 54) represents the varying size and shape of the blood-corpuscles of different animals.

FIG. 54.



COLOURED BLOOD CORPUSCLES (after Wagner)—1. Human; 2. Camel; 3. Dove; 4. Proteus; 5. Water Salamander; 6. Frog; 7. Cobitis; 8. Ammocœtus. *a.* Views in profile; *b.* Views from edge.

In man and *in all mammalia* (excepting the camel tribe) the blood-corpuscles are circular, and apparently without nuclei. There is some reason, however, to believe that a nucleus is really present, as may be seen by examining them with high powers on an opaque ground. (See Dr. Roberts' papers.)

In the *camel tribe* the corpuscles are about the size of those of other mammalia, without apparent nuclei, but of an *oval* shape.

In *birds*, *reptiles*, and *fish* the corpuscles are also oval, but are distinctly nucleated, generally of a larger size, and especially in the reptilia. The diameter of the blood-corpuscle in man varies from the 1-2800th of an inch to 1-4000th, 1-3200th being an average. They have an average thickness of the 1-12,400th of an inch. The blood-corpuscles of embryonic life are usually considerably larger, and sometimes nearly double the size.

The following measurements are taken, by the kind permission of Mr. Gulliver, from his extensive tables in the "Proceedings of the Zoological Society of London." The blood was allowed to dry in a thin layer on the slide; and the measurements are all in vulgar fractions of an English inch, and express only the average diameters of the red blood-corpuscles or their nuclei. The enumerator, being invariably one, is omitted throughout, and the denominators only are printed. Of the corpuscles, the long diameter is denoted by L. D., the short diameter by S. D., and the thickness by T.

Vertebrata Apyrenæmata.

SEU MAMMALIA.

Human	3,200
,,	T. 12,400
,, fœtus (5th mo.)	3,000
Lemur	3,976
,,	4,003
,,	4,440
Monkey	3,368
,,	3,342
,,	3,412
Ape	3,510
,,	3,602
Bat	4,404
,,	4,000
,,	3,880
Mole	4,747
Polar bear	3,870
Brown bear	3,723
Lion	4,322
Cat	4,404
,,	T. 16,000
,, fœtus (½ inch long)	2,223
,, nucleus	4,600
Hyæna	3,735
Dog	3,542
Tiger	4,419
Leopard	4,319
Fox	4,177
Dolphin	3,829
Whale	3,099
Pig	4,230
Elephant	2,745
Horse	4,600
,,	T. 13,422
Ass	4,000
Ox	4,267
,,	4,571
Sheep	5,045
Goat	5,300
Deer	7,060
Camel	L. D. 3,123
,,	S. D. 5,876
,,	T. 15,210
Dromedary	L. D. 3,254
,,	S. D. 5,921
,,	T. 15,337
Hare	3,560
Rabbit	3,607
Mouse	3,814
Rat	3,754

Vertebrata Pyrenæmata.

PISCES.

Common eel	L. D.	1,745
,,	S. D.	2,842
Conger eel	L. D.	2,286
,,	S. D.	3,000
Sprat and herring	L. D.	2,666
,, ,,	S. D.	3,555
Salmon	L. D.	1,524
,,	S. D.	2,460
Carp	L. D.	2,142
,,	S. D.	3,429
,,	T.	8,000
Carp, nucleus	L. D.	6,400
,, ,,	S. D.	8,000
Cod	L. D.	2,133
,,	S. D.	3,555
Sole	L. D.	2,400
,,	S. D.	3,200
Perch	L. D.	2,099
,,	S D.	2,824
,,	T.	8,700
Perch, nucleus	L. D.	6,000
,, ,,	S. D.	8,000
Sharks	L. D.	1,148
,,	S. D.	1,600

Sharks, nucleus	L. D.	3,000
,, ,,	S. D.	4,000
,, fœtus	L. D.	1,000
,, ,,	S. D.	1,333
Ray	L. D.	970
,,	S. D.	1,455

BATRACHIA.

Amphiuma tridactylum, or Congo-lizard	L. D.	363
,, ,, ,,	S. D.	615
,, ,, nucleus	L. D.	1,143
,, ,, ,,	S. D.	2,000
Proteus anguinus	L. D.	400
,, ,,	S. D.	727
,, nucleus	L. D.	1,600
,, ,,	S. D.	2,666
Frog	L. D.	1,108
,,	S. D.	1,821
,,	T.	7,112
,, nucleus	L. D.	3,114
,,	S. D.	6,297
Tadpole (½ inch long)	L. D.	1,098
,,	S. D.	1,650
Toad	L. D.	1,043
,,	S. D.	2,000
,,	T.	5,627
,, nucleus.	L. D.	2,802
,,	S. D.	5,261

REPTILIA.

Boa constrictor	L. D.	1,440
,, ,,	S. D.	2,400
Crocodile	L. D.	1,231
,,	S. D.	2,286
,,	T.	8,000

Tortoise	L. D.	1,252
,,	S. D.	2,216
Turtle	L. D.	1,231
,,	S. D.	1,882
,, nucleus	L. D.	4,000
,, ,,	S. D.	6,000

AVES.

Eagle	L. D.	1,812
,,	S. D.	3,832
Falcon	L. D.	1,916
,,	S. D.	3,862
Crow	L. D.	1,961
,,	S. D.	4,000
Song Thrush	L. D.	2,305
,, ,,	S. D.	4,133
,, ,, nucleus	L. D.	4,000
,, ,, ,,	S. D.	9,600
Parrot	L. D.	2,029
,,	S. D.	3,892
Pigeon	L. D.	2,100
,,	S. D.	3,512
Pheasant	L. D.	2,213
,,	S. D.	3,615
Peacock	L. D.	1,835
,,	S. D.	3,589
Common fowl	L. D.	2,102
,, ,,	S. D.	3,466
,, ,, nucleus	L. D.	6,400
,, ,, ,,	S. D.	4,000
Partridge	L. D.	2,376
,,	S. D.	3,728
Ostrich	L. D.	1,649
,,	S. D.	3,000
,,	T.	9,166
,, nucleus	L. D.	3,200
,, ,,	S. D.	9,166
Duck	L. D.	1,937
,,	S. D.	3,424

Oval corpuscles may be made globular by the addition of too much water. For other details and measurements, reference must be made to Sonnenschein (Handbuch der gericht. Chemie), who quotes Schmidt (die Diagnostik verdächtiger Flecke, &c.), to the Micrographic Dictionary, to numerous works on the Microscope, and on Physiology, and to Papers by Fleming, Woodward, and others, in the "American Journal of Medical Sciences," 1857 to 1876.

As many of the foreign measurements, not only of blood-corpuscles, but of hairs, and other microscopic objects are in millimètres, the following table for the conversion of foreign into English measures may be found useful. It is taken from the Micrographic Dictionary.

	Millimètres into English inches.	Old Paris Lines into English inches.	Prussian Lines into English inches.
1	·039,370	·088,815	·085,817
2	·078,741	·177,630	·171,633
3	·118,112	·266,445	·257,450
4	·157,483	·355,260	·343,267
5	·196,853	·444,075	·429,083
6	·236,224	·532,890	·514,900
7	·275,595	·621,705	·600,717
8	·314,966	·710,520	·686,532
9	·354,337	·799,335	·772.350

In using this table, the decimal fraction to be converted into parts of an English inch must be broken up into its decimal parts, and each valued separately from the table. Thus to convert 0·75 mm. into a fraction of an English inch :—

0·7 mm. = 0·0275595 } By table.
0·05 mm. = 0·00196853 }
0·75 mm. = 0·02952803 English inch.

Great attention is required in placing the decimal point.

Microscopic Examination of a Blood-Stain.

In the microscopic examination of a blood-stain proceed as follows :—

Either cut out the stain, or else take a small fragment of the supposed clot, and place it on a microscope-glass. Moisten it with a mixture of seven parts of water, and one part of glycerine (*i. e.* a solution having a specific gravity of 1030). Professor Filippo Pacini recommends, instead of the glycerine, a solution of chloral hydrate (1 to 10 of water), which he states softens, without dissolving, the blood-corpuscles. Cover the specimen with a thin covering-glass, and examine it with a $\frac{1}{4}$th inch power. Measure the corpuscles with a micrometer.

Examine with great care any structures associated with a blood-stain. The discovery of hairs, of different forms of epithelium (pavement epithelium from the vagina being very generally found in menstrual blood), the presence of biliary, or of fæcal matter, of brain tissue, of spermatozoa, or of numerous other "little" matters (as they are often called), may tend very materially to elucidate a case submitted for your examination. Possibly, too, by noting the various matters mixed with the blood, some clue may be found to determine its source.

Bodies likely to be Mistaken for Blood-Corpuscles under the Microscope.

1. *Starch-corpuscles* sometimes simulate blood-discs. A careful attention to their shape, external markings, and behaviour with polarized light, will easily distinguish them. A solution of iodine will also be found to turn them of a blue colour.

2. *The sporules of certain fungi* closely resemble blood-discs, but they refract light more strongly. The application of iodine or magenta will generally bring out a real nucleus, and, with warmth and moisture, they will be seen actually to *grow* upon the slide. Dr. Richardson states that a solution of sulphate of soda often contains such fungi.

3. *The discs found in coniferous woods* (deal, cedar, &c.), *and other gymnosperms,* simulate closely the blood-discs of many mammals. The double ring which surrounds their pits, their formal arrangement in rows, the presence of woody-fibres, and a careful attention to their size, will in most instances prevent the experienced microscopist from making a mistake. Their refraction of light is also different.

Dr. Day's Guaiacum Resin Test.

We must now speak of Dr. John Day's beautiful test for blood, a reaction depending on the oxidation of guaiacum resin.

Schönbein discovered that peroxide of hydrogen (H_2O_2), formed, as he supposed, of water and antozone, was decomposed in the presence of blood, the antozone being converted into ozone. Now the precipitated resin of tincture of guaiacum is found to be strongly acted upon by ozone, being changed in colour by it to a bright sapphire blue, whilst it is not acted on by antozone. Hence it becomes a test for blood.

Proceed thus:—Make your *tincture of guaiacum fresh each time you require it,* the old tincture being useless. Wash the tears first with a little alcohol, and then dissolve the pure unoxidized guaiacum resin by shaking up with a little fresh spirit. Wet the stain with this guiacum tincture, which should not blue it by itself; and then add either a small quantity of an ethereal solution of peroxide of hydrogen (manufactured by Robbins, in Oxford-street), or ozonic ether, or a watery solution of $H_2 O_2$. If blood be present, the guaiacum will be rapidly oxidized, and acquire the characteristic bright blue colour. If the material that is stained be of such a colour as to obscure the reaction, add the several re-agents, and press the stained fabric between two pads of white blotting-paper, when the blue colour will be absorbed by the blotting-paper, and be at once apparent. By repeating the process a number of impressions may in this way be obtained.

Dr. Day has further applied the guaiacum test to the detection of mucus, pus, and saliva.

Professor Falck has suggested the use of strips of paper dipped in tincture of guiacum which has been freely exposed to the air, as a preliminary test for blood-stains. These papers are not affected by red lead, cinnabar, the common dye stuffs, carmine, logwood, alkanet-root, the red aniline dyes, or the juice of cranberries or whortleberries. On the other hand, the juice of cherries, currants, and raspberries, as well as of certain fungi, instantly blue it.

In our opinion, although the combined use of ozonized ether and tincture of guaiacum, as suggested by Dr. Day, is a very neat and beautiful test, it should never be relied upon *by itself alone,* as a positive proof of the stain being blood. (*See* Remarks on Single Tests under Poisons, Class V.)

Guaiacum is known to be easily blued by a great number of substances; and, amongst others, the following may be named—viz., gluten, as in the cut surface of a raw potato, or a mixture of wheaten flour, or of gum arabic, with cold water; milk, the fresh juice of various roots and underground stems (horse-radish, colchicum, carrot, &c.); nitric acid, spirit of nitrous ether, ozone, chlorine, hypo-nitrous ether, chlorides of iron, mercury, copper and gold, and alkaline hypochlorites; a mixture of hydrocyanic acid and sulphate of copper; pus, saliva, and mucus, if mixed with carbolic acid, or creosote, &c. &c.

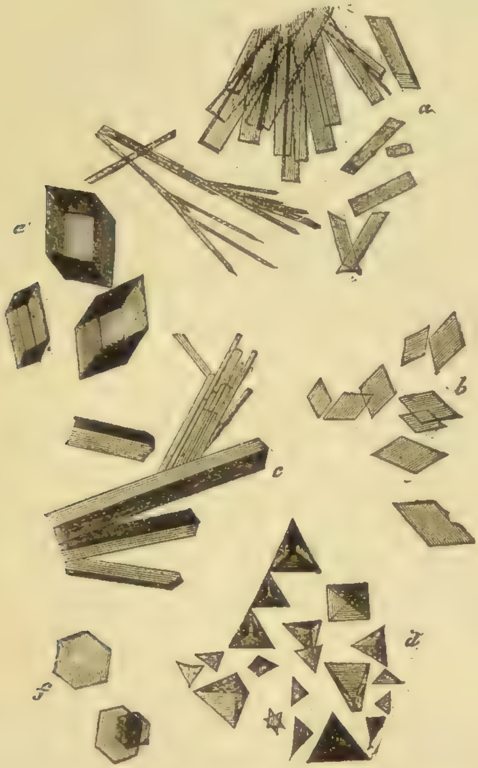
Blood Crystals.

Another test for blood consists in the characteristic crystals of hæmoglobin it may be made to yield (Fig. 55). It is unfortunate that the value of this test is so much impaired by the necessity, in order to produce them, of examining fresh and unaltered blood. The crystals obtained prove there is some difference between the hæmoglobin of different species of mammalia, inasmuch as crystals have been noticed belonging to two distinct crystalline systems (rhombic and hexagonal), and differing both in their secondary forms, as well as in their solubility.

Whilst some day these facts may present us with a means of proving from what animal a given specimen of blood was derived, Preyer concludes that at present it cannot be relied upon as a means of distinguishing human blood from that of other animals.

The crystals such as are given above may be obtained from a portion of a clot a day or two old. It must first be diluted either with a little chloroform, or spirit, or ether, and placed on a microscopic slide, then covered over with a thin glass, and put aside to crystallize.

FIG. 55.



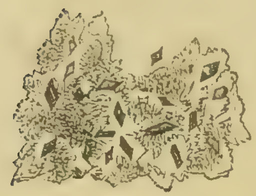
BLOOD CRYSTALS :—*a*. Human Blood Crystals (Prismatic) ; *b*. Human Blood Crystals (?), Hæmin ; *c*. Human Blood Crystals, Hydrochlorate of Hæmatin ; *d*. Guinea-pig's Blood Crystals ; *e*. Horse (?) ; but sometimes human take same shape ; *f*. Crystals from Squirrel's Blood.

Sometimes you get these crystals to form easily and rapidly, whilst at other times the experiment is not so successful. The crystals from human blood are prismatic and flattened.

Teichmann's Test, as modified by Neumann and others.

The red stains suspected to be blood, whether on textile fabrics, wood, stone, or metallic instruments, are to be first dissolved in a small quantity of cold distilled water. If the stain be on a fabric, or on wood or stone, it is well to cut out or chip off the spot from its surroundings. A little of the watery extract is then to be mixed with a few drops of glacial acetic acid, and cautiously evaporated on a glass slide, over a spirit-lamp, till the fluid runs together in globules, and begins to solidify. Then after rapidly cooling the slide, we immediately observe under the microscope, using a one-fourth inch objective, a multitude of small, brownish-black rhomboids (Fig. 56), amongst which crystals may be observed, which present the form of St. Andrew's Cross (X), in consequence of two of the crystals crossing. It is sometimes necessary to add a small quantity of a weak solution of sodium chloride, or of ammonium chloride, or else solution of the salts may be used in the first instance for the purpose of dissolving the stain. In this case cubical crystals may often be seen mixed with those of hæmatin and hydrochlorate.

FIG. 56.



Liebreich says this hæmin or hæmatin crystal-test is one of the most certain. He suggests that murexide crystals (purpurate of ammonia, of Prout) might, however, be mistaken for them. By burning them on platinum, and testing for iron (which is absent from murexide, but present in blood-crystals), we should be able to detect their true nature. Murexide crystals, also, look green by reflected, and purple-red by transmitted light.

Methods suggested for distinguishing Human from other Blood.

Again and again the question has been asked, "Can we distinguish human from animal blood?" Much time and much learning has been spent in attempting an answer. Hæmatolloscopy, as suggested by Taddei of Florence; the various reactions of phosphoric acid, as suggested by M. Casanti; the different effects of iodine-water, as suggested by Berlazzi, are some of the futile attempts at reply. M. Barruel, in 1829, suggested that the blood of different animals contained special and different odoriferous principles, and the odours were developed, he considered, sufficiently well for recognition, on the addition to the blood of strong sulphuric acid. Although there is a shadow of truth in this, we consider it far too doubtful a test to be of any positive use.

Professor J. G. Richardson (of Pennsylvania) first proposed the use of high powers, such as the $\frac{1}{25}$ and $\frac{1}{50}$ of an inch, magnifying with a micrometer eye-piece, 1250, and 3700 diameters respectively, for the purpose of distinguishing human blood-discs from those of many other mammals. ("American Journal of Medical Sciences," July, 1869, No. CXV., p. 50.) Under the $\frac{1}{50}$ inch human blood-corpuscles appear about $\frac{9}{8}$ of an inch in diameter, whilst those of the ox and the sheep are about $\frac{5}{8}$ of an inch only. It appears from a subsequent paper in the same journal, for July, 1874, No. CXXXV., p. 102, that he has succeeded in identifying the three kinds named above, with no other clue than his own measurements. He scrapes the blood-stain with a knife, puts the scrapings on a slide, covers with thin glass, and adds a $\frac{3}{4}$ per cent. solution of common salt. His measurements of 100 red corpuscles freshly drawn (from five different persons), give an average of $\frac{1}{3378}$ of an inch, whilst the measurement of 20 corpuscles for one of these *dried* in a thin film upon a slide, gave a maximum of $\frac{1}{2800}$, a minimum of $\frac{1}{3621}$, and a mean of $\frac{1}{3182}$ of an inch. Dr. Wormley measured seven red discs, with an average of $\frac{1}{3236}$ of an inch, whilst Dr. Richardson's average of the measurements of the same discs was $\frac{1}{3266}$. There was thus a difference of only $\frac{1}{352292}$ of an inch. He argues, reasonably enough, that his experiments *prove* that the red blood-globules of the pig ($\frac{1}{4320}$), the ox ($\frac{1}{4267}$), the red deer ($\frac{1}{4324}$), the cat ($\frac{1}{4404}$), the horse ($\frac{1}{4600}$), the sheep ($\frac{1}{5300}$), and the goat ($\frac{1}{6866}$ of an inch), being all so much smaller than even the ordinary minimum size of the human red disc, enables us to distinguish positively, by the aid of high powers of the microscope, under favourable circumstances, stains produced by human blood, from those caused by the blood of any of the animals just enumerated, even after the lapse of five years from the date of their primary production. (*See* the Measurements, p. 599.)

The rest of Mr. Gulliver's careful micrometric measurements of blood-corpuscles from various animals will be found in the "Proceedings of the Zoological Society," No. CII., and in his edition of the "Works of Hewson," Sydenham Society, p. 237. The following measurements of Schmidt (made under a power of 500 diameters) have been reduced from millimètres to fractions of an English inch :—They represent *freshly dried* specimens —Human blood-corpuscles $\frac{1}{3254}$ to $\frac{1}{3335}$, dogs $\frac{1}{3703}$, rabbits $\frac{1}{4000}$, rats $\frac{1}{4000}$, pigs $\frac{1}{4166}$, mouse $\frac{1}{4165}$, ox's $\frac{1}{4545}$, cat's $\frac{1}{4545}$, horse's $\frac{1}{4545}$, sheep's $\frac{1}{5555}$, domestic fowls $\frac{1}{3437}$ broad, and $\frac{1}{2000}$ long, and those of the frog $\frac{1}{1666}$ broad by $\frac{1}{120}$ long. We cannot again enter into the general question of microscopic measurements; but some idea of the subject may be gained by referring to the figure on page 573. An object measuring $\frac{1}{1000}$ of an inch, seen with a power of 250 diameters, would occupy five of the divisions on the left, or $\frac{1}{4}$ inch, because $\frac{250}{1000} = \frac{1}{4}$. But a rabbit's (fresh dried) blood disc, measuring only $\frac{1}{4000}$ of an inch, seen with the same power, would only occupy $\frac{1}{16}$ of an inch, or $\frac{1}{4}$ of $\frac{1}{4}$, equivalent to one and a half of the lines on the left.

Methods suggested for Distinguishing Menstrual from other Blood.

Can we distinguish menstrual from ordinary blood? We urge, in reply, the necessity for great caution. It is stated—

(1) That menstrual blood contains no fibrin.

(2) That menstrual blood is acid, owing to its admixture with vaginal mucus; and,

(3) That menstrual blood will invariably be found associated with the pavement epithelium from the vaginal walls. Further than this it is difficult to go; nor in the present state of science should we be justified in venturing a positive opinion in the case of a stain as to its being menstrual or otherwise.

Lastly. Having proved conclusively that the stain is a blood-stain, we venture, at the risk of being accused of needless repetition, to add a word of caution. You will probably be asked three questions in the witness-box—

(1) Was the blood human?

(2) From what part of the body was it derived? and,
(3) What is the probable age of the stain?

To these questions, as a rule, you had better confess your inability to reply. Never venture rash answers. The replies can, save in a few exceptional cases, be little else than guesses; and it is dangerous in the extreme to guess in the witness-box.

CHAPTER XX.

Life insurance—The normal man—The Presumption of death and of survivorship —Causes of death, and modes of dying.

Of late years life insurance or assurance has assumed vast proportions. All sound and reputable offices now select the lives offered to them, and the duty of this selection or choice of "lives" rests with medical men. It has been well remarked by Mr. Babbage, that "nothing is more uncertain than the duration of life, when the maxim is applied to the individual; but there are few things less subject to fluctuation than the duration of human life in a multitude of individuals." In other words, the writers or the reader of this do not know how long they shall live—whether only a few days or a few years. But if we take 1000 persons, or still better, 10,000 of the same age, we can predict, with almost absolute certainty, the number who will die within any given period. This is the principle of annuities, life insurance, the Tontine, &c.; and were it otherwise it would be impossible for such institutions to succeed. Some readers may not unnaturally ask, "Why do the assurance companies make large profits, and declare bonuses?" The explanation is very simple. These offices make their charges on the scale of either the old Northampton tables of mortality, 1780, or from the Carlisle tables of 1816. Recent experiences, drawn from larger numbers, such as those of the seventeen life offices published in 1843, of government annuitants, and of twenty life offices collected in 1868, show that the average of mortality is less than was assumed from the smaller numbers of the first tables. The limits of this work forbid the discussion of this topic at any great length. We must therefore refer the reader to the articles on these subjects in the principal Encyclopædias; to the reports of Dr. Farr, and the Registrar-General; to "Popular Tables," by C. M. Willich and M. Marriott, London, 1857; to "Medical Statistics of Life Assurance," by Dr. J. G. Fleming, Glasgow, 1862; to the "Etude Médico-légale sur les Assurances sur la Vie," Paris, 1866; to the statistical works of M. Quetelet; and for a brief, but excellent summary of the subject by Dr. Sieveking, entitled "The Medical Adviser in Life Assurance," Churchills, 1874; and to Dr. Brinton's "On the Medical Selection of Lives for Assurance," 2nd ed., 1856. The Manuals of Forensic Medicine of Drs. Taylor and Guy, more especially the former's, also contain good summaries of the medico-legal aspects of this subject. Two such Tables, however, appear to us to deserve a place in our pages. The first includes all classes of life, and is as follows:—

TABLE TO SHOW THE PROBABLE DURATION OF HUMAN LIFE IN ENGLAND.

(According to the calculations of William Farr, Esq., in the Sixth Annual Report of the Registrar General.)

Age (or Birth-Days).	Mean Future Lifetime— in Years.			Age (or Birth-Days).	Mean Future Lifetime— in Years.			Age (or Birth-Days).	Mean Future Lifetime— in Years.			Age (or Birth-Days).	Mean Future Lifetime— in Years.		
	Persons.	Males.	Females.		Persons.	Males.	Females.		Persons.	Males.	Females.		Persons.	Males.	Females.
0	41	40	42	24	38	37	38	48	22	21	22	72	8	8	8
1	47	47	48	25	37	36	38	49	21	21	22	73	8	7	8
2	49	49	50	26	36	36	37	50	21	20	21	74	7	7	7
3	50	50	50	27	36	35	36	51	20	19	20	75	7	7	7
4	50	50	50	28	35	34	36	52	19	19	20	76	6	6	7
5	50	50	50	29	34	34	35	53	19	18	19	77	6	6	6
6	50	49	50	30	34	33	34	54	18	17	18	78	6	6	6
7	49	49	50	31	33	32	34	55	17	17	18	79	5	5	6
8	49	48	49	32	32	32	33	56	17	16	17	80	5	5	5
9	48	48	48	33	32	31	32	57	16	15	16	81	5	5	5
10	47	47	48	34	31	30	32	58	15	15	16	82	5	4	5
11	47	46	47	35	30	30	31	59	15	14	15	83	4	4	4
12	46	46	46	36	30	29	30	60	14	14	14	84	4	4	4
13	45	45	46	37	29	29	30	61	13	13	14	85	4	4	4
14	44	44	45	38	28	28	29	62	13	12	13	86	4	3	4
15	44	43	44	39	28	27	28	63	12	12	13	87	3	3	3
16	43	43	43	40	27	27	28	64	12	11	12	88	3	3	3
17	42	42	43	41	26	26	27	65	11	11	12	89	3	3	3
18	42	41	42	42	26	25	26	66	11	10	11	90	3	3	3
19	44	41	41	43	25	25	26	67	10	10	10	91	3	3	3
20	40	40	41	44	25	24	25	68	10	9	10	92	2	2	2
21	40	39	40	45	24	23	24	69	9	9	10	93	2	2	2
22	39	39	39	46	23	23	24	70	9	[illegible]	9	94	2	2	2
23	38	38	39	47	23	22	23	71	8	8	9	95	2	2	2
												93	..	..	..

For this Table we are indebted to Smith's Visiting List, edited by Seymour Haden, Esq.

The next Table is taken from "The Mortality Experience of Life Assurance Companies, collected by the Institute of Actuaries," C. and E. Layton, 1869. It is the experience of twenty offices, but differs from the other, in being the result of selected lives.

TABLE OF EXPECTATION OF LIFE.

Age.	H. M. Healthy Lives, Male.	H. F. Healthy Lives, Female.	H. M. F. Healthy Lives, Male and Female.	D. M. F. Diseased Lives, Male and Female.	Age.	H. M. Healthy Lives, Male.	H. F. Healthy Lives, Female.	H. M. F. Healthy Lives, Male and Female.	D. M. F. Diseased Lives, Male and Female.
	Years of Life.	Years of Life.	Years of Life.	Years of Life.		Years of Life.	Years of Life.	Years of Life.	Years of Life.
0	58·43	55·53	57·64	55·56	50	20·30	21·60	20·51	18·29
1	57·43	54·53	56·64	54·56	51	19·63	20·94	19·84	17·73
2	56·43	53·53	55·64	53·56	52	18·97	20·18	19·17	17·13
3	56·31	52·53	55·09	52·56	53	18·29	19·60	18·50	16·52
4	55·31	53·04	54·83	51·56	54	17·60	18·86	17·81	15·93
5	54·31	52·04	53·83	50·56	55	16·93	18·17	17·14	15·45
6	53·76	51·04	53·08	49·56	56	16·32	17·53	16·53	14·84
7	53·13	50·90	52·67	48·56	57	15·69	16·88	15·90	14·20
8	52·13	49·90	51·67	47·56	58	15·07	16·16	15·26	13·74
9	51·13	49·18	50·80	46·56	59	14·44	15·56	15·64	13·23
10	50·29	48·18	49·89	45·56	60	13·80	14·85	13·99	12·62
11	49·69	47·78	49·38	44·56	61	13·23	14·21	13·42	12·19
12	48·69	46·78	48·38	43·56	62	12·66	13·50	12·83	11·60
13	47·88	45·78	47·50	42·56	63	12·09	12·92	12·26	11·09
14	47·05	44·78	46·60	41·56	64	11·54	12·38	11·72	10·64
15	46·24	44·27	45·90	40·56	65	11·01	11·78	11·17	10·26
16	45·34	43.82	45·14	39·56	66	10·49	11·24	10·65	9·85
17	44·34	43·11	44·23	39·09	67	9·98	10·63	10·12	9·38
18	43·53	42·20	43·39	38·09	68	9·46	10·10	9·61	8·99
19	42·79	41·42	42·64	37·09	69	8·99	9·60	9·13	8·56
20	42·09	40·87	41·98	36·80	70	8·54	9·12	8·68	8·16
21	41·33	40·17	41·23	36·16	71	8·02	8·61	8·16	7·67
22	40·62	39·40	40·51	35·73	72	7·52	8·09	7·65	7·18
23	39·87	38·61	39·84	35·15	73	7·12	7·58	7·24	6·77
24	39·18	37·95	39·15	34·84	74	6·69	7·27	6·83	6·32
25	38·44	37·40	38·44	34·01	75	6·42	6·99	6·56	6·10
26	37·64	36·80	37·65	33·47	76	6·03	6·57	6·17	5·90
27	36·90	36·21	36·93	32·87	77	5·69	6·29	5·85	5·69
28	36·14	35·69	36·18	32·36	78	5·33	5·92	5·48	5·58
29	35·42	35·07	35·47	31·64	79	5 00	5·86	5·22	5·21
30	34·68	34·55	34·75	31·03	80	4·71	5·56	4·93	4·98
31	33·96	33·90	34·04	30·46	81	4·40	5·17	4·61	4·60
32	33·21	33·27	33·30	29·81	82	4·14	4·90	4·36	4·52
33	32·48	32·75	32·59	29·13	83	3·90	4·35	4·04	4·17
34	31·75	32·04	31·86	28·43	84	3·79	3·92	3·84	3·52
35	31·03	31·43	31·15	27·76	85	3·51	3·71	3·58	3·01
36	30·28	30·80	30·41	27·11	86	3·34	3·62	3·44	2·87
37	29·55	30·21	29·69	26·51	87	3·13	3·51	3·26	2·69
38	28·83	29·55	28·97	25·75	88	2·87	3·40	3·05	2·99
39	28·12	28·88	28·27	25·13	89	2·81	3·14	2·94	2·78
40	27·42	28·24	27·57	24·49	90	2·35	3·33	2·68	4·05
41	26·69	27·59	26·85	23·82	91	1·91	3·88	2·46	3·05
42	25·96	26·97	26·14	23·15	92	1·55	3·72	2·25	2·90
43	25·24	26·30	25·42	22·51	93	1·40	3·71	2·34	3·50
44	24·50	25·68	24·69	21·80	94	2·21	3·25	2·90	2·50
45	23·79	24·96	23·98	21·11	95	1.21	2.25	1·90	1·50
46	23·08	24·26	23·27	20·95	96	·50	1·25	1·06	·50
47	22·37	23·68	22·57	20·26	97	—	1·00	1·00	—
48	21·68	23·02	21·89	19·57	98	—	·50	·50	—
49	20·98	22·34	21·20	18·92					

If we exclude all under 25, and all above 75, from our calculations, we shall find that the formula of Willich is not far from the truth. It is as follows:—

$$[x = \text{expectation of life},\ a = \text{age}]$$

$$x = \tfrac{2}{3}\,(80 - a).$$

For example—Let a man's age be 30 years, then $80 - 30 = 50$, and $\frac{2}{3}$ of $50 = 33·3$ years. By Dr. Farr's table, the expectation is 33 years for males, and 34 years for females at that age. By the experience of the twenty offices (Table II.), the expectation is 34·68 for the former, and 34·55 for the latter. Again, suppose the age to be 65, then by this formula—

$$x = \tfrac{2}{3}\,(80-65) = 10 \text{ years.}$$

Now, by Table I., the expectation is 11 years for males, and 12 years for females, and by Table II. it is 10·26 years for diseased lives, and 1·117 for healthy male and female lives. De Moivre supposed that out of 86 persons born, one dies every year, till they are extinct. Therefore, according to him, the decrement of life $y = \frac{100{\cdot}000}{86} = 1163$ throughout life. Then the present value of an annuity of £1 to be continued during the life of an individual of a given age, allowing compound interest for the money, is (supposing n to be the number of years which any individual wants of 86) $\dfrac{\overline{n-1}.\, r - n + \frac{1}{r\,n} - 1}{n.\,(r-1)^2}$ = (if P be the present value of an annuity of £1 to continue certain for n years) $\dfrac{1 - \frac{r}{n}\,\text{P.}}{r-1}$

But although the principles of calculation are similar, Dr. Young's formula for the decrement of life (*see* "Encyclopædia Metropolitana," and "Phil. Trans." 1826,) is certainly far nearer the truth. This is (y being the number of deaths among 100,000 persons in the year that completes the age x) in an abbreviated form, and for the middle portion of life—

$$y = 368 + 10\,x.$$

For example, let x or the age be 40, then of 100,000 persons of the age of 40, we shall expect that 768 will die before the year is out, the actual number in Dr. Young's Table (referred to above) being 785. Most treatises on arithmetic now contain tables of the values of £1 at different rates of compound interest for a given number of years, and those conversant with arithmetical and algebraic calculations may, from the data we have now given, calculate the probable value of an average healthy life, and the present value of an annuity. Such questions are, however, in our courts of law, very properly put to actuaries, and not to medical men. As a corollary to these remarks on the *Expectation of Life*, we may quote the following table from Dr. Southey (which is, we believe, found in substance at least in Hippocrates), of the *Expectation of Sickness* at different ages :—

Age in Years.	Days ill yearly.
20	4
20—30	5—6
45	7
50	9—10
55	12—13
60	16
65	31
70	74

If we take the ages of 20 to 60, we shall find the average number of days of sickness to be as nearly as possible *eleven days in a year*. Dr. Dickson's experience in the Customs agrees with this. Owing to a variety of causes, it is scarcely possible to assign any such number of days for infants or very young children. The questions which you will be asked in your medical capacity are really far more difficult, and can only be answered with even approximate correctness by those who have carefully studied their profession, not only theoretically but practically (that is, clinically). The principal questions of this kind which you will have to answer are as follows:—

I. Is the life of the proposed assurer [male or female] a healthy one?

II. If not a healthy life, how many additional years' premiums will cover the probable risk?

III. Are, or were, the habits of the assured, or intending assurer, such as tend to shorten life? Or has his occupation any tendency to the same?

IV. Supposing death to have occurred, was the disease acquired since the insurance?

V. A policy may be claimed when there is no actual proof of death, and the question may be raised—Is it to be presumed that the insurer is dead?

VI. If a body be found, how long has it been dead?

VII. Is the body that of the assurer?

In order to save useless repetitions, we shall take some of these questions in the reverse order. The last question is clearly one of *personal identity*, and belongs to the next chapter.

Question VI., is often one of extreme difficulty. In the *Wainwright Trial*, Dr. Bond was *reported* to have sworn that the body supposed to be that of Harriet Lane, had certainly been dead a certain number of months. In Chapter III., under the headings of *Adipocere* and *Putrefaction*, you may gain some hints as to how such a question may be answered. It is, however, far better to state the facts, and to decline mere guessing when the circumstances of the case are such as to preclude your really forming a well-grounded opinion.

Question V. is that of *presumption of death* or *survivorship*. For considerable detail and many curious cases, we must refer the reader to Beck, Taylor, and Guy, contenting ourselves with just indicating the general principles which must guide our judgment. Dr. Taylor states, on the authority of Best ("On Presumptions of Law and Fact"), that "when a person goes abroad, and has not been heard of for a long time, the presumption of the continuance of life ceases at the expiration of seven years from the period at which he was last heard of. The same rule holds generally with respect to a person who has gone away from his usual place of resort, and of whom no account can be given, but the presumption does not extend to the *time* of his death: *i.e.*, whether he died at the beginning or at the end of any particular period of the seven years." We may remark incidentally that this rule is generally acted upon in cases where a husband deserts his wife, or *vice versâ*, or if either married person go abroad, not intending to desert the other, and have not been heard of for seven years, it is not considered bigamy if the one left behind marry again. But this is not strictly a medico-legal question, the fact of death of any person once known to be alive is a matter of fact to be determined by a jury in most cases. Where the decision has rested with our judges (as in the Court of Chancery), the question has sometimes been left open where there was no evidence as to death. In

Watson v. *England*, the absence of any news of a female who left her father's house 34 years before was not considered by the Vice-Chancellor as proof of her death. Best (quoted by Taylor) remarks that the Court of Queen's Bench said that they could not assume judicially, that a person alive in the year 1034 was not alive in 1827! (op. cit. p. 190). Absurd as this may seem, cases are on record in which men who had been absent from their homes many years, have suddenly returned. In *Church* v. *Smith*, a husband who had deserted his wife fourteen years, and had not been heard of for twelve years, walked into court just as his wife was suing to be deemed a widow! In the cases of lost and missing ships, accidents, &c., after which no tidings arrive for many years, law and common sense are on the same side. Insurance offices, too, usually pay policies after the lapse of a year or two, when no news can be gained of the life insured. One such case has been very recently decided, as regards a tailor who lived in Cheltenham, and whose life had been insured for £500.*

Presumption of Survivorship.

There appears to be no definite law in England as to the presumption of survivorship. In other words, in any accident or mode of death common to several individuals (such as shipwreck, fire, suffocation, &c.), our law supposes that all died at the same moment, unless there be evidence or reasonable proof to the contrary. For example: in the cases mentioned by Dr. Taylor, the first, in which General Stanwix, his wife, and daughter by a previous marriage, were supposed to have perished at sea in 1766, no decision was given as to survivorship, and a compromise was effected on the recommendation of Lord Mansfield. In another case, mentioned by the same author (*loc. cit.* vol. i., p. 169), a woman aged forty-two, in feeble health, a stout healthy daughter of twenty, and a son aged six, were drowned on the coast of Norfolk. Here the medical probabilities were that the daughter, aged twenty, survived; but Dr. Lushington, in the absence of proof, ruled that they all perished together. In another case, of death by fire, the marks of burning on one body were evidently produced during life, on the other after death,

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* In connection with this matter of presumption of death or survivorship, a very important case has recently been tried at Croydon (July 28th, 1875), before the Lord Chief Baron Kelly—the case of Edmonds *v.* The Prudential Assurance Company. The plaintiff sued to recover on a policy of £500 on the life of Robert Nutt, a tailor, who was born at Cheltenham on Nov. 21st, 1833, led a somewhat dissolute life, left Cheltenham in May, 1867, and had not been heard of for eight years. In fact, the last time seems to have been in August, 1867. There was some conflict of evidence on this point, the height and personal appearance being very differently given by different witnesses. The verdict was for the defendants (the Prudential), on the ground of "insufficient proof of death." Mr. Edmonds has kindly informed us in a note, that he has a bill of exceptions, signed by the Judge, against this ruling (pursuant to 13 Edw. I., stat. 1, cap. 31), which will be heard before the judges of Appeal, when he hopes to succeed in getting a new trial, on the ground that the Judge wrongly directed the jury in telling them that they must find for the defendants unless they were satisfied the man had not been heard of for seven years, but that they should have found for the plaintiff, there being no "sufficient and evident proof" of his being *alive*, as required by the statute of 19 Car. II., cap. 6. Should the new trial be granted, and a verdict found on this ground, the remarks in the text must clearly be modified. It is usual, however, for insurance offices to pay similar claims, when they have no reason to suspect fraud or collusion, within a short period (six to twelve months) after the supposed death.

(*see* Burns, Scalds, &c.), and Dr. Ollivier therefore inferred that the former body was that of the one who lived the longest. A number of cases are given in Taylor and Beck, but they all confirm the statement above, as to the practice of our English courts. As the question is one of some general interest, it may not be amiss to state the Roman law, that of the Code Napoléon, and the modern Prussian law. In the old Roman law, according to Beck (*loc. cit.* pp. 358-9), when persons of different ages died in battle, those under puberty were deemed to have died first; but if a father and a son who had attained his majority died together, the son was, very properly, considered to have survived the father. This in time was extended to all cases where the precise time of death was unknown. In the case of husband and wife, the husband was esteemed the survivor. Beck quotes the following from the "Digest," lib. xxxiv. tit. 5, *de rebus dubiis* :—"Cum pubere filio mater naufragii periit, cum explorari non posset, uter prior extinctus sit, humanus est credere, filium diutius vixisse. Si mulier cum filio impubere naufragio periit, priorem filium necatum esse intelligitur," &c. The decisions given by Zacchias and the older writers were essentially founded on the same principles.

The French law, as contained in the Code Napoléon, is as follows :—

"If several persons, naturally heirs of each other, perish by the same event, without the possibility of knowing which died first, the presumption as to survivorship shall be determined by the circumstances of the case; and in default thereof, by strength of age and sex.

"If those who perished together were under fifteen years, the oldest shall be presumed the survivor.

"If they were all above sixty years, the youngest shall be presumed the survivor.

"If some were under fifteen, and others above sixty, the former shall be presumed the survivors.

"If those who have perished together had completed the age of fifteen, and were under sixty, the male shall be presumed the survivor where ages are equal, or the difference does not exceed one year.

"If they were of the same sex, that presumption shall be admitted which opens the succession in the order of nature. Of course the younger shall be considered to have survived the elder."

(Taken from Foderé, vol. ii., p. 221; Beck, p. 361.)

The Prussian Common Law (Part I., tit. 1, § 39) and Civil Code (Arts, 720, 721, 722), quoted by Casper (Dr. Balfour's Trans., vol. i., p. 14), are identical in spirit, though not in the precise wording, with the Code Napoléon.

We believe these rules to be fairly correct, although children have been known to survive long journeys and voyages better than adults. The young suffer most from cold, the aged from heat. In death from starvation, those who have the freest access to water will probably live longest. In shipwrecks we may presume that a man is more likely to be able to swim than a woman. On the other hand, a woman may be buoyed up by her clothes; she may faint, and thus life may be preserved; and rather stout people often float better than thin ones. They are also supposed to bear starvation better. For other physiological and medical reasons, for presumption of survivorship we must refer to the works of Beck and Guy; only remarking that in the rare case of a woman and infant both dying, without witnesses, in childbirth, most medical writers are agreed that the general probabilities are for the survivorship of the mother. It appears to us that no general rule could be safely laid down, as a living child may be born after the death of the mother. The mother has the risk of hæmorrhage—no light risk; whilst the chief dangers to which the child would ordinarily be exposed are suffocation and cold.

The question, "Is this a healthy life?" which is in fact the meaning of a medical examination of persons about to insure their lives, is one which is answered far too carelessly by many medical men. There can be no reasonable question that a careful selection of lives is one of the first elements of stability in an office. The "European," "Albert," and other offices which were careless in this matter, soon came to an end, although no doubt there were other sources of failure. Most Life Offices propose to intending assurers a series of questions relating to their personal and family history. The medical referee also has a similar paper to fill up. Of these we have selected that of the Sovereign Life Office for an example :—

SOVEREIGN LIFE ASSURANCE COMPANY.

* *Signature of the person examined* ________________ *To be signed in the presence of the Medical Referee.*

Private and Confidential MEDICAL REPORT *made to the Directors respecting the health of the above-named.*

1. Is the party to be examined personally known to you? and if so, how long?

2. Has the Applicant ever had Small Pox, or been Vaccinated, or had Measles, Hooping Cough, Scarlet Fever, Typhus, Intermittent, or any other kind of Fever?

*3. Has Applicant ever had Gout, Apoplexy, Rheumatism, Dropsy, Liver Complaint, Fistula, Insanity, Habitual Cough, Asthma, Hæmoptysis, Hernia, Piles, Stricture, or any Disease of the Urinary Organs?

* Please inquire into the accuracy of the replies given to Questions 11, 12, and 13 *of the proposal.*

4. *Are there any indications of Phthisis?*

5. Has Applicant ever been under Medical or Surgical Treatment for any affection specified or not in the above question, and has recovery been complete?

In the case of a married female, please inquire as to the character of her accouchements, if any.

*6. Are the Applicant's Parents living? If not, at what ages and of what disorders did they die?

*7. How many of the Applicant's Brothers or Sisters are living? At what ages and of what disorders have any died?

8. What is the Applicant's Personal Appearance as to Age, Weight, Stature, Complexion, Temperament, and General Development of the Head, Neck, Chest, and Abdomen?

9. After Stethoscopic examination, please give your opinion as to the state of the Thoracic Organs, specifying the condition of the Circulation, Respiration, and frequency of Pulse?

10. Apparent state of Digestive Functions?

11. Is there any apparent predisposition to Hereditary Disease, and have Gout, Cancer, Apoplexy, Insanity, or Phthisis existed in the family?

12. *What is your opinion of the Applicant's habits of life: temperate or otherwise: active or sedentary?*

(Please inquire what amount of stimulant is usually taken per diem.)

13. Do you recommend the Directors to accept the Applicant as a first-class Life or as a fair Average?

(If below the Average, please state if an addition to the Premium would meet the case, and if so, how many years' addition would you suggest.)

I hereby certify and declare that the Answers given by me, a Medical Examiner acting for the Company, in relation to the proposed Assurance, are the result of a personal examination of the above-named, and that they are, according to the best of my knowledge and judgment, faithful and just, and made after a careful consideration.

Examined and dated this ______ *day of* ________ 18

(Signed) ____________________ } *Please add*
Residing at ____________________ } *Medical Title.*

Initials of Examiner, __________

In the Great Britain Mutual Life Assurance Society there are some additional queries, such as—"Has he recently lost or gained in weight?" "Has he the appearance of a healthy and temperate person?" "Does h personal appearance lead you to apprehend apoplexy?" and, under "Respiration," "Whether subclavian regions expand well and equally on deep inspiration, and are equally and normally clear on percussion?" "Whether respiratory murmur under clavicles and elsewhere is such as in health?" and, under the heading "Circulation," "Whether veins are swollen in any part?" This Society is also, very properly, particular as to present and past pregnancy of female assurers, and the number and character of the confinements, if any. And, as "*Supplementary* General Questions," they ask the proposed assurer, "Do you know of any other circumstances connected with your family, or personal constitution, health, or habits, that can in any way affect your prospects of life or health?" Most offices inquire if the applicant have resided abroad, and if he has any intention of doing so.

On reviewing a number of these papers, the authors are of opinion that the offices attach too little importance to the signs or evidences of kidney disease, including under that term the various forms of *Morbus Brightii*, *Diabetes insipidus*, and *Diabetes mellitus.* In examining a proposed assurer, it is well to have some method, and in our opinion the simplest method which is likely to give good results is the following:—

Investigate, in turn, the following systems:—

1. *The Nervous System* (with which may be included the *Muscular*, since tremor of muscles is generally of nervous origin, and the tonicity or otherwise of muscles is also greatly dependent on the nervous system).—Under this heading paralysis, loss or increase of sensibility (hyper- and an-æsthesia), affections of the senses (sight, smell, hearing, &c.), will all be included. And particular inquiries should be made as to neuroses in the family (such as chorea, epilepsy, insanity, &c.).

2. *The Respiratory System.*—Since about one in six, or 16·6 per cent. of all the deaths in this country are from diseases of the lungs (including the bronchi and air-passages), it is clear that great importance should be attributed to this system. Referring to the tables a little further on for some constants as to the development of the chest, &c., it may be stated in general terms—that healthy breathing or respiration (including, of course, the double act of inspiration and expiration in the one term "respiration"), should be quiet, easy—in the ratio of one to four or five of the pulse—not exceeding twenty per minute in adults; the chest should be expanded in at least three directions—upwards, forwards, and sideways—or, more truly, in all directions; and the muscles of the neck and arms (auxiliary muscles) should not take any very active or visible part in the act. If the blood be well aërated, the lips, and ears, and tips of the fingers should not have any purple or livid tint. The respiratory murmur should be gentle, like a slight breeze amongst the trees—not harsh or noisy. Drawing a full breath, and holding it for a few seconds, should cause no distress or pain. An adult should be able to count aloud, rather slowly, from twenty to thirty without drawing fresh breath.

3. *The Circulatory System.* (For tables of the pulse at different ages, see page 626.)—Since diseases of the heart, of almost every kind, have, practically, only two terminations—the one, *Sudden death* (fatty and brown degeneration, aortic regurgitation, disease of the coronary arteries, dilatation, and atrophy); and the other, *Dropsy* (a common ending to almost every form of disease of the heart and its appendages); Life Insurance Offices very properly attach great importance to this organ. Dr. Begbie ("Edinb. Med. Journ.," Dec. 1874) found, from the experience of the Scottish Widows' Fund Life Assurance Society from 1815-1873, that one-third of the cases with heart disease actually lived *longer* than the average expectation of life. In accordance with this is the experience of many practical physicians and our own, that many cases of valvular disease of the heart may attain to a good age if their surroundings are favourable, and they are careful. But the remaining two-thirds of these cases bore out the general idea as to the great risks involved in disease of this centre of life. Thus these diseases constituted 14·202 per cent. of all the deaths (800 in 5,633) during that period, and they amount to about one in twenty, or 5 per cent. of the deaths from all causes certified to the Registrar-General. (Infants under one year are not included in this number.) In forming an estimate of the condition of the heart, the following are the chief data:—The pulse

should be regular, not too compressible nor hard (hardness indicating disease of the artery), nor jerking; its number should be four or five to each respiration; and in the case of adults, sitting, should not be below 70, nor above 80 or 85, per minute. (Exceptional cases of very slow pulse, and very rapid pulse, with good health, are met with, but they are extremely rare.) There should be no intermission, and change of posture should not make more than about ten beats per minute difference. The sounds of the heart (well imitated by "lúbb-dŭpp, lúbb-dŭpp") should be clear, and not attended with any murmur or blowing sound, or rubbing (bruit or friction). The first should be somewhat the louder, longer, and lower-pitched; the second sound somewhat shorter, sharper, and higher-pitched, and not quite so loud. The second sound should not be snapping, or slapping in character, nor should it be accentuated or more marked than the first. The apex-beat of the heart should be 1½ inch within and about the same distance below the left nipple (in the fifth costal interspace); and the impulse, whilst plainly perceptible, must not be jerking or too widely diffused.

4. *The Digestive System.*—Although it may be quite true that "creaking hinges last a long while," and that people with very feeble digestions live a very long time, yet the importance of this system is certainly very great; as might be expected, since the vital forces cannot long be maintained without supplies from without; and scarcely any of these supplies can be utilised in the economy unless previously digested. Those who have good digestion will, *cæteris paribus*, live the longest, bear most fatigue, and stand the risks of tropical climates and exposure to contagion best. It is in this direction, too, that habits of intemperance (chronic alcoholism) make themselves most felt. The principal points for investigation here are—the state of the tongue and mucous membrane of the mouth, appetite, regular action of the bowels, and the presence or absence of symptoms of dyspepsia; the size of the liver, the colour of the skin and conjunctivæ, the presence or absence of abdominal tumours, &c.

5. *The Genito-Urinary System.*—A sample of the urine of twenty-four hours, and a sample passed at the time of examination, should, if possible, be examined. The following are bad indications:—Puffiness of the eyelids, backs of hands, and dorsum of the foot; œdema of the scrotum (or vulva) or prepuce; nocturnal micturition; morning sickness (apart from pregnancy)—this symptom is very common in dram-drinkers; lumbar pains; dysuria; the presence in the urine of albumen, sugar (except in the most minute traces), pus, blood, phosphates, uric acid, urates, and oxalates in any quantity or persistently (constituting gravel or minute calculi); bile-pigment, epithelial and other tube-casts from the kidney; cancer-cells, and a very high or very low specific gravity, with any marked increase or decrease in the quantity of urine. (The sp. gr. of healthy urine is from 1015 to 1025; the daily quantity about 40—60 oz, which should contain from 400 to 500 grains of urea in the whole quantity; the colour should be pale amber; the reaction acid, but not too strongly so; the odour peculiar, animal, but not disagreeable. It should deposit only a slight cloud of mucus after standing ten to twelve hours, and should be transparent, not opalescent, when passed.) As regards the generative organs, sexual incapacity in males is an early symptom of diabetes and of many neuroses. It must be remembered, too, as regards females, that the uterus and ovaries are favourite

seats of cancer and cystic disease respectively. In the male a stricture of the urethra must be regarded as an element of danger. It is well known that albuminuria and granular or contracted kidneys are unfavourable prognostics for the success of operations, or for recovery from accidents and diseases.

Summary.

In examining for life insurance, carefully examine your patient's general appearance, inquire into his family history, auscultate heart and lungs, count his pulses and respirations, take his temperature (if there be any heat of skin), examine the urine, look at the tongue, and inquire into the digestive functions, habits of life, and amount of stimulants taken.

III. In reply to the question as to the influence of occupations and habits of life on health, we cannot, in this place, do more than give general answers. In the first place, it is generally allowed that out-door occupations, provided the man is temperate, are more favourable to health and longevity than sedentary ones. It would appear, however, from the long life of literary men, clergymen, and lady-annuitants, that the great mortality of clerks, tailors, shoemakers, and others of sedentary life, is to be attributed rather to working in bad air, or to other unhealthy conditions of life, than to the mere fact of their occupations being sedentary. The lives which are considered specially risky, and liable to early death, are :—

A. *All those whose occupations expose them to risks of poisoning.*—Amongst poisons, *Alcohol*, or rather the beverages which contain it, appears to hold the first place ; for—

(1) Many Insurance Offices decline the lives of publicans and hotel-keepers altogether (unless specially certified as to their sobriety), barmen, potmen, brewers' draymen, and other servants. Distillers' men, cellarers, and all employed in the manufacture, sale, and distribution of alcoholic beverages, are included in this class. Soldiers, sailors, butchers, watermen, the police, auctioneers, and others are liable to special temptations to drink, but are also exposed to other risks from the nature of their callings.

(2) Those engaged in chemical manufactures, or works in which lead, arsenic, copper, mercury, phosphorus, and the mineral acids are either made or employed, are subject to special risks. (*See* these poisons in the toxicological part.)

(3) Those exposed to sewer-gases or emanations from decomposing animal and vegetable matters ; scavengers ; the makers of blood-manures, &c. Intemperate habits, however, play a great part here.

B. Those exposed to risks from gunpowder or other explosives, to the falling in of rocks, earth, &c., and in part also to poisonous gases ; miners of all sorts ; quarrymen ; excavators ; workers in gunpowder, fireworks, dynamite, &c., &c.

C. Those whose work is very dusty : millers ; those employed in grinding cutlery and hardware ; mill-stone dressers and stonemasons ; coal-miners, &c.

D. People of sedentary habits, who work in badly-ventilated, close, and perhaps dark rooms, or whose hours of work are long. Factory-hands, clerks, drapers, and millinery assistants, shoemakers, and tailors, printers, bakers (these are also exposed to dust and carbon dioxide, or carbonic acid), and the employés in theatres, music halls, and the like, may all be classed here.

E. Those whose occupations expose them to special risks from mechanical violence, falls, and injuries purposely inflicted, or whose callings take them into unhealthy climates. Soldiers, sailors, policemen, firemen, bricklayers and builders (including carpenters, and bricklayers' labourers), plasterers, cabmen, omnibus drivers, grooms, and all who have to do with horses. All these classes are, unfortunately, but too much given to alcoholic liquors.

As regards unhealthy climates, we refer especially to "Scoresby-Jackson on Climate," and to the chapter on the subject in Dr. Aitken's "Science and Practice of Medicine." In general it may be said that most of Europe, North America, including the Northern part of the United States, the North of Asia, Southern Australia, New Zealand, the Cape Colony, the south of South America, and most islands, are fairly healthy; except the low-lying districts, especially on the sea-board, and the estuaries of large rivers, certain cities and towns, such as Liverpool—marshy and undrained lands—and certain special localities, as the Campagna of Italy, the Island of Walcheren, certain districts in the Alps renowned for Goitre and Cretinism, etc., etc. On the other hand, what are generally known as the Tropics (in other words, the district between 23° 28′ N., and the same distance S. of the equator), are with few exceptions, far more unhealthy than more temperate climes, from the prevalence of plague, yellow fever, cholera, dysentery, small-pox, leprosy, and other diseases. Indeed, this remark may be extended beyond the true tropics, and nearly the whole district between 25° of North latitude and 25° of South latitude must be considered risky. Here, too, exceptions must be made, as some parts, especially the hill-country, of Hindostan, and some parts of Persia and Africa, are not unhealthy.

When the cause of death is quite unknown, what are the probabilities of any given mode of death? is a question rather curious than practical in the present state of our knowledge. As far, however, as the United Kingdom goes, the labours and researches of the Registrar-General, and especially of Dr. Farr, have enabled him to calculate the mathematical probability of death from most of the recognised causes. Thus, for example, in the year 1871, after deducting the number of deaths of children under one year old, which amounted in 1871 to 125,865, the number of other deaths in that year amounted to 389,014, or 17·08 per thousand, thus giving to the inhabitants of England and Wales who escape death in their first year, an average lifetime of 58·51 years. The following table is compiled from the deaths from each cause in 1871, the deaths in that year being within 0·2 per thousand of the average of the 34 preceding years:

Class of Disease.	Total Number of Deaths.	Number of Deaths from 1000.	Probability of any person dying of the specific disease during any one year.
Zymotic class (or fevers), including Small-pox, &c.	124,126	5·418	182 to 1
Small-pox, at rate of 1871	23,126	1·01	989 to 1
Diseases of Organs of Respiration	81,825	3·565	276 to 1
Heart Disease	26,190	1·15	868 to 1
Nervous Diseases (brain, &c.)	25,309	1·11	900 to 1
Child-bearing	2,471	·091	—
All violent Deaths	15,903	·752	1,319 to 1
Railway Accidents	1,126	·05	20,000 to 1
Murder and Manslaughter	381	·17	58,823 to 1
Suicide	1,495	·065	15,384 to 1
Diseases of Digestive Organs (including Liver)	21,625	·95	1,052 to 1

The deaths from small-pox in 1871 were immensely above the average, the number for twenty-four years previously not having exceeded 8,000, and in the two previous years having been only 1,565, and 2,620, the real probability of dying from small-pox being thus about one-tenth of that given above. It appears from the Report that of 100,000 persons who have been *vaccinated*, 100 may expect in any year to have the disease, and ten of these to die. Of persons *not* vaccinated, it is calculated that in 100,000, 600 will be infected in the same time, and 270 die, the probability being 26 to 1 in favour of persons vaccinated. In persons having *one or more clear marks*, the mortality was but 4 in 100 of those attacked. With *bad* or *indifferent* marks, the mortality was 25 in 100, and in patients *without marks* (presumably non-vaccinated), the deaths were 48 in 100 of those attacked. The laws of vaccination are now so generally known that we need only summarise them thus:—*Primary* vaccinations are to be done at three months from birth. A Public Vaccinator must not refuse to vaccinate children duly brought to him. He must examine the child on the eighth day after, and certify if successful. He must not certify that a child is insusceptible of successful vaccination, unless he has vaccinated it three times unsuccessfully. All certificates must be sent to the vaccination officer for the district. All necessary forms can be obtained from the Local Government Board. Re-vaccination must be limited by the following conditions: (1) That so far as he can ascertain, the applicant has attained the age of fifteen years, or if, during any immediate danger of small-pox, twelve years, and has not before been successfully vaccinated; (2) that there are no sufficient medical reasons to render re-vaccination undesirable; (3) that he can afford lymph without postponing the claims for primary vaccination. The fees for primary vaccinations must not be lower than the following scale:—At the station or within one mile from the public vaccinator's residence or the parish workhouse, 1*s.* 6*d.*; over one mile and under two miles, 2*s.*; over two miles, 3*s.* Public vaccinators must not charge the parents or other persons (except the guardians who appoint him), any fees for the operation, or for certificates.—Distances are to be measured by the nearest carriage road. The fees for re-vaccination (secondary vaccination) are two-thirds of those given above. Besides this, public vaccinators of some standing (one year at least) get some extra fees (not exceeding one shilling per case), when the work has been personally done, and is of very good quality, and the number of cases is great. Parents refusing to allow their children to be vaccinated, or refusing to allow lymph to be taken, are subject to a fine of 20*s.*, the same for obstructing a public vaccinator in his work. The fines may be repeated, and have been in some cases a dozen or more times. There is nothing in the Acts relating to vaccination preventing medical men who are not public vaccinators from making special contracts to vaccinate the children of well-to-do parents, who desire their children to be vaccinated by their own medical attendants.

THE NORMAL MAN.

It is clearly not within the scope of a handy-book like this, to enter largely in detail into questions which can only be answered by a thorough knowledge of physiology. There are, however, a few matters so strongly affecting the question of personal identity, that it seems desirable to include them here, partly because some are matters of interest or importance in regard to life assurance, and partly because, both in life and death, you may often be asked questions, in regard to which it is desirable to have some handy-book of reference.

(1) *Of Dentition.*

As long ago as 1837 Mr. Edwin Saunders, in his pamphlet "The Teeth a Test of Age," called attention to the value of the teeth as a method of (approximately) ascertaining the age of children, who were to be certified as fit for factory labour. It is well known that human beings have two periods of dentition. The following Tables show the number and position of the teeth, relative to each other, in each set, and the relation of those of the temporary to those of the permanent series, and the average periods of their eruption.*

		Molars.	Canines.	Incisors.	Canines.	Molars.		
Temporary Teeth	Upper -	2	1	4	1	2	= 10	= 20.
	Lower -	2	1	4	1	2	= 10	

		Molars.	Præ-Molars or Bicuspids.	Canines.	Incisors.	Canines.	Præ-Molars or Bicuspids.	Molars.		
Permanent Teeth	Upper -	3	2	1	4	1	2	3	= 16	= 32.
	Lower -	3	2	1	4	1	2	3	= 16	

Periods of Eruption of Temporary Teeth.

6th or 7th month, two middle incisors.

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* The first two of these tables are taken from Wilson and Buchanan's Anatomist's Vade Mecum, which also contains a good description of the individual characters of each kind of tooth, p. 84–92. *See* also "Dental Surgery" By J. and S. C. Tomes: Churchills.

9th	month,	two lateral incisors.
12th	,,	first molars.
18th	,,	canines.
24th	,,	two last molars.

The Periods for the Permanent Teeth are:—

6th or 7th	year,	first molars.
7th	,,	two middle incisors.
8th	,,	two lateral incisors.
9th	,,	first bicuspids or præmolars.
10th	,,	second bicuspids or præmolars.
11th to 12th	,,	canines.
12th to 13th	,,	second molars.
17th to 21st	,,	last molars or "wisdom teeth."

As regards the molar teeth, we may assume the seventh, fourteenth, and twenty-first years as the periods at which the 1*st*, 2*nd, and* 3*rd molars respectively will have been cut*, in the vast majority of cases. Every one's own experience will have furnished him with instances of the wisdom-teeth being cut late in life. Other irregularities in dentition are also familiar to all who have studied the subject. Supernumerary teeth are not unknown. We lately saw a lady, aged 70, who was cutting a canine tooth. Instances are not wanting of dentition at a more advanced period of life. Thus in the German *Ephemerides* (dec. ij. ann. 3. p. 57), it is stated that a man 118 years old, cut a complete front set with excruciating pain, and was seen alive, two years after, at Clives, in 1666. Even a complete third set has been mentioned (John Hunter, "Nat. Hist. of the Teeth"). See also the "Philosophical Transactions," "Mason Good's Works," "Van Swieten's Commentaries," and the "Dictionnaire des Sciences Médicales, art. Cas rares." On the other hand, children are sometimes born with teeth, generally the upper central incisors. This was the case with *Dentatus*, who was consul with P. Cornelius Rufinus, B.C. 290. At certain ages, however, the jaws may normally contain more teeth than the full number even of 32. For instance, between six and seven years of age, the jaws may contain 48 teeth, 20 of the temporary set in a perfect state, and 28 of the permanent set more or less developed, and placed behind the temporary teeth, which they are to replace. Mr. Saunders gives the following as the order of the permanent teeth (which will be seen to closely correspond with the table above).

At	7	years of age the	4 anterior *molars*.
,,	8	,,	4 central *incisors*.
,,	9	,,	4 lateral *incisors*.
,,	10	,,	4 anterior *bicuspids*.
,,	11	,,	4 posterior *bicuspids*.
,,	12 to 12½	,,	4 cuspidati or *canines*.
,,	12½ to 14 years		4 posterior *molars*,

thus making 28 teeth at the latter age.

At 9 years of age there would generally be 12 permanent teeth, viz., 8 incisors, 4 molars. At 13 years 28, viz., 8 incisors, 4 canines, 4 bicuspids, and 4 molars. In examining 1046 children, whose ages were known, Mr. Saunders found that 389 out of 708 of 9 years of age had the full development for their age. But on the principle urged by him that *where the teeth of one side are fully developed, those of the other side should* *be reckoned,* 530 came up to the standard. Of the remainder, none, judged by the teeth, would have varied more than a year from the standard—and this always by deficiency.

Again, of 338 children of 13 years of age, no less than 294 might have been pronounced with confidence to be of that age. Of the remaining 44, 36 would have been considered as in their 13th year, and 8 near the completion of their 12th year. [Mr. Saunders' pamphlet contains all the data on which these decisions are grounded. Unfortunately our space precludes their republication.] In connection with the teeth, two diseases are worthy of special note. *Rickets* retards the development, especially of the first set. Many rickety children reach 11 or 12 months of age without a tooth in their head. *Syphilis,* on the other hand, causes certain peculiarities in the permanent teeth, which have been pointed out by Mr. Hutchinson, and are now generally quoted in Medical and Surgical Manuals. Syphilis, unlike rickets, rather hastens the eruption of the teeth, particularly of the first set. As regards their decay, the wisdom-teeth are, as the Lord Chief Justice Cockburn remarked in the Tichborne trial, "the last to come, the first to go." The incisor teeth, from their situation, are most exposed to injuries and accidents, and the bicuspids and 1st molars are also especially liable to decay.

HEIGHT AND WEIGHT AT DIFFERENT AGES.

The subjoined figures are reduced from the French weights and measures given in Quetelet's "Anthropométrie" (Brussels, 1870). They are the arithmetic means (averages) of a very large number of observations, chiefly on inhabitants of Brussels; and although they are probably a little under the mark as regards English boys, girls, and adults, they are, on that account, better adapted for medico-legal purposes, in which it is desirable to avoid all appearance of exaggeration.

MALES.			FEMALES.		
Age in Years.	Height in Inches.	Weight in Pounds.	Age in Years.	Height in Inches.	Weight in Pounds.
Birth	19·7	6·8	Birth	19·3	6·6
1	27·5	19·8	1	27·	18·9
2	31·	24·2	2	30·7	24·2
3	34·2	27·5	3	33·6	27·2
4	36·6	30·8	4	35·9	30·5
5	38·8	34·9	5	38·5	33·6
6	41·2	39·1	6	40·7	36·7
7	43·4	43·3	7	42·9	39·1
8	45·7	47·5	8	45·5	41·8
9	48·1	51·7	9	47·4	46·2
10	50·4	55·4	10	49·2	50·8
11	52·5	59·4	11	50·6	56·1
12	54·5	63·8	12	52·7	63·8
13	56·4	72·8	13	55·8	71·5
14	58·6	81·6	14	58·1	79·8
15	61·	90·6	15	58·9	88·
16	63·	99·8	16	59·8	95·7
17	64·6	109·3	17	61·1	102·9
18	65·2	118·5	18	61·6	109·5
19	65·6	126·7	19	61·8	114·6
20	65·8	130·9	20	62·	117·
21	*65·5	134·6	21	62·1	119·4
22	*66·2	138·3	22	,,	120·
23	*66·2	141·9	23	,,	121·4
24	*65·9	,,	24	,,	,,
25	*66·3	145·6	25	,,	120·5
27	*66·4	144·9	27	,,	121·2
30	66·3	145·4	30	,,	121·6

The heights with asterisks are from Danson.

A recent report of Dr. Bridges has shown that the result of factory work is greatly to deteriorate the height and weight of the workers and their children. On comparing this table with the former, the discrepancy of weight is more apparent than that of height. It is, we think, to be explained by Dr. Bridges' weights including the clothes. The first table refers only to height :—

Age.	Factory Children of factory Parents.		Children in non-factory districts.	Non-factory Children of non-factory Parents in factory districts.
		Inches.	Inches.	Inches.
8	Male ……	45·75	46·66	46·72
	Female ….	46·48	46·73	47·40
9	Male ……	48·05	49·21	49·09
	Female ….	47·62	48·63	49·37
10	Male ……	46·77	51·00	51·02
	Female ….	49·52	50·07	49·76
11	Male ……	51·44	52·87	52·57
	Female ….	50·80	53·66	52·80
12	Male ……	52·82	54·05	53·56
	Female ….	53·13	54·41	53·39

The following table is a similar one for average weight :—

Age.	Factory Children of factory Parents.		Children in non-factory districts.	Non-factory Children of non-factory Parents in factory districts.
		Pounds.	Pounds.	Pounds.
8	Male ……	55·60	55·08	53·15
	Female ….	50·73	52·82	53·64
9	Male ……	58·41	60·02	59·40
	Female ….	54·63	56·53	57·79
10	Male ……	62·14	65·29	63·76
	Female ….	59·75	61·19	60·78
11	Male ……	67·22	71·01	70·22
	Female ….	63·94	68·00	68·97
12	Male ……	70·74	75·00	70·94
	Female ….	71·46	75·95	70.55

Here we remark that factory boys, of factory parents, are, on the average, at eight years old nearly one inch shorter than those of either of the other classes, and at 12 those of non-factory districts have gained another half-inch in height over the factory boys. With girls the same results appear in a lesser degree. As to weight, the factory boys start ahead of both the other classes, but at twelve years old those of non-factory districts exceed the others by some 5 lb. ; while the girls, who start 2 lb. behind, lose nearly 3 lb. more as compared with Class 2.

Some particulars as to the height of skeletons, &c., will be found under personal identity, in the next chapter.

A writer in the "London Medical Record," thus summarises the chief facts as to weight. At birth, boys weigh a trifle more, girls a trifle less than six pounds. For the first 12 years the weight of both sexes is nearly equal, after this the male is in excess. Thus males at 20 weigh on an average 143 lbs. and females only 120 lbs. Men attain their greatest weight about 35, women go on gaining weight up to 50, their mean weight at this age being about 128 lbs. In advanced age both sexes weigh about 15 times their weight at birth. Men weigh from about 108 lbs. to 229 lbs. Women 88 lbs. to 207 lbs. The mean weight of all ages and all ranks, and both sexes, is about 100 lbs. per person. The weight of grown-up people is usually estimated by the *stone* of 14 lbs. Thus a man of 140 lbs. weight is said to be a man of 10 *stone* weight. Stout people, of course, often exceed enormously the weights given above. Thus when the claimant to the Tichborne estates was incarcerated in Dartmoor Jail, he weighed 392 lbs. (28 stone), but this weight has been often exceeded. The following table gives the average weights of very young children :—

		lbs.	oz.				lbs.	oz.
At birth	......	6	8	7 months		......	13	4
1 month	......	7	4	8	,,	......	14	4
2 months	......	8	4	9	,,	......	15	8
3 ,,	......	9	6	10	,,	......	16	8
4 ,,	......	10	8	11	,,	......	17	8
5 ,,	......	11	8	12	,,	......	18	8
6 ,,	......	12	4					

Dwarfs and giants being admittedly *lusus naturæ*, scarcely come within the limits of a work like this. It may, however, be remarked that Quetelet's estimate even of these is generally true, that *giants* are seldom more than half as much again as the average height ($1\frac{1}{2}$ times), and dwarfs are seldom less than half the usual height. Excluding the accounts of giants in Scripture and in ancient writers, the following are modern instances of great heights :—

J. Middleton, born in 1578, . .	was	9	feet	3	inches.
C. Munster (Hanoverian), died in 1676,	,,	8	,,	6	,,
Cajanus (Swede, exhibd. in London in 1742)	,,	9	,,	0	
C. Byrne, died in 1783, . . .	,,	8	,,	4	,,
Cotton O'Brien (contemporary with above),	,,	8	,,	$7\frac{3}{4}$	,,
Peter Tuchan (Posen) died in 1829, .	,,	8	,,	7	,,
Anna Swan (living), ...	,,	8	,,	0	
Captain Bates (ditto), ...	,,	8	,,	0	
Chang-wu-gon (Chinese giant—living) .	,,	7	,,	9	,,

The following may be mentioned as celebrated for their dwarfishness :—

Jeffrey Hudson (King Charles First's dwarf), said to have been only 18 inches at the age of 30 years, afterwards grew to 3 feet 9 inches. Count Boruslavski, died in 1837, was 35 inches at 25 years of age. Bébé (dwarf of Stanislas, of Poland), 33 inches. Wybrand Lolkes, born in 1730, was only 27 inches high at 60 years of age. Madame Teresia, the "Corsican Fairy," was born in 1743. She was only 34 inches high, and is said to have been remarkable for beauty and esprit.

RELATION OF STATURE TO RESPIRATORY CAPACITY.

Dr. Hutchinson's beautiful researches on Respiration ("Transactions of the Royal Med. Chirurg. Soc.," vol. xxix.), led him to the conclusion that the *vital capacity*, in other words, the quantity of air which can be expelled from the lungs by a forcible expiration (after the deepest inspiration), is 225 cubic inches at a temperature of 60° F., for a man 5 feet 7 inches in height. For every inch above this standard the capacity is increased, on an average by about 8 cubic inches; for every inch below this height, it is diminished by the same amount. For some reasons, not easy to explain, the dimensions of the chest itself, and the weight of the body, do not seem very greatly to affect this vital capacity. Women are said, by Bourgery, to have only half the capacity of breathing that men of the same age have—but some of our *Prima donnas* would seem to disprove this. Phthisis, emphysema, chronic bronchitis, and other diseases of the chest, greatly diminish the vital capacity.

THE PULSE AT DIFFERENT AGES.

The pulse of an adult in the middle ages of life, when quiet, varies from 70 to 75 or 80 per minute. This is, of course, much affected by exercise, and position. But by few things more than age, as is seen in the following table:—

		Per minute.
In the embryo, the average number of pulsations is		150
Soon after birth	,,	140—130
During the 1st year	,,	130—115
During the 2nd ,,	,,	115—100
,, 3rd ,,	,,	100— 90
About the 7th ,,	,,	90— 85
,, 14th ,,	,,	85— 80
In adult life	,,	80— 70
In old age	,,	70— 60
In decrepitude	,,	75— 65

It is said that the female pulse is naturally a little quicker than that of the male. [See the fine article by Dr. Guy, in the "Cyclopædia of Anatomy and Physiology."] The authors have met with several instances of *hereditary slow* pulse, without obvious disease. In one instance a gentleman, now nearly 70, has had a pulse of only 24 per minute ever since puberty. It can scarcely be doubted that there may be idiosyncrasies of *rapid* pulse without disease. But the *rule* is that a rapid pulse, especially if above 100, in an adult, indicates disease—and in many instances, phthisis, or at least a tendency to it. [*See* also Dr. Guy, "Guy's Hospital Reports," Nos. vi. and vii.]

PREGNANCY AND CHILDBEARING.

Brief as our sketch of Life Insurance is, we cannot dismiss it without just alluding to the important subjects of Pregnancy and Childbearing. Very few married women die whilst actually pregnant (only

35 deaths of pregnant women were registered in England and Wales in 1871). It must not, however, be hastily assumed that pregnancy is any shield from risk for any longer period than that of actual gestation. About 1 in every 200 women still die in childbed throughout the country, though in the town of Lewes from the year 1820 to 1835, only 1 in 1205 died thus. Dr. Allen has collected tables from a number of obstetric authorities,* which show strikingly how much greater risk is run by primiparæ than by multiparous females. Thus of 10,382 women confined for the first time, 168, or 1 in every 62, died; whilst of 26,394 multiparæ, only 213 died, or 1 in every 124. Reduced to percentages, the risk would stand thus:—To primiparæ, 1.612, to multiparæ, 0.806. We feel it right to remind you that the ignorance of midwives and of some medical accoucheurs is to blame for much of this mortality, the great bulk of which ought to be prevented. As regards Life Insurance, it is however a simple fact, which cannot be left out of calculations on the subject.

Habits injurious to life—Medico-legal questions in disputed policies.

There can scarcely be any room for doubt that habits of excessive drinking tend to shorten life. The question will generally be, whether the assurer, or the life assured, was aware of such habits, or gave way to such habits at the time the life was insured. This was the question in *Jay* v. *The Gresham Life Assurance Company*, in which the defendants asserted that Mrs. Jay was intemperate at the time the Doctor insured her life. Some collateral issues were raised, but this was the chief. The question of *Opium*-eating, or the habitual use of opium, has also been raised. We think, although many opium eaters undoubtedly achieve longevity, that it cannot be doubted that the habitual use of any narcotic must tend to injure health. We therefore agree with Dr. Taylor in this matter. It should, however, be noted that opium has anti-periodic qualities, and therefore in malarious districts might tend to prolong life. The *law of tolerance* previously mentioned in our remarks on poisons, must not be forgotten here. If, however, opium be dangerous, the far too common constant use of chloral hydrate, chloroform, and ether, must be regarded as fraught with far more danger—for the danger here is of sudden death, which can seldom happen to the habitual opium eater, as a direct consequence of his indulgence. Other questions arise, as to suicide, the reality of death, &c., which must generally be settled on their own merits—the consideration which underlies them all in Life Assurance, being that Life Insurance is a covenant or agreement binding both parties, which is void if the parties insuring do not strictly comply with the conditions—one of which is to disclose, at the time of insuring, all matters pertinent to health and life. Our space does not allow of more than a tabular reference to the chief cases of interest in this matter. We must confess our obligations to Dr. Taylor for most of these, and many of the details will be found in his work (*loc. cit.*).

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* "Medical Examinations for Life Insurance," by J. A. Allen, M.D. (New York 1872), p. 175.

Names of Plaintiffs and Defendants.	Amount Insured.	Reasons given for disputing.	Date of Action.	Verdict.	Remarks.
Hiorns & Drew *v.* Railway Passengers' Insurance Company.	£250	Only clothes found. Body found 150—160 miles from Brighton. Could not be identified.	Exchequer, Guildhall, Feb., 1862.	Jury could not agree. No verdict.	Was a bankrupt, and had insured his life in several offices.
Executors of Fowkes *v.* the Manchester & London Assurance Company.	£1000	Alleged concealment of gout.	Dec., 1862. (Lord Chief Justice.)	For plaintiffs, with point reserved.	His life had been approved by the medical referee of another office, but not *accepted* as he declared.
Sweet *v.* Fairlie, Globe. (Life of one Abraham.)	£5,000	Concealment of gout.	Feb. 20, 1833.	Verdict for plaintiffs.	
Von Lindenau *v.* Desborough. (Life of Duke of Saxe-Gotha in Atlas Office).	£3,208	Concealment of cerebral symptoms.	Oct., 1828. (Lord Tenterden.)	Plaintiff elected to be nonsuited, but a new trial was refused. ("Med. Chir. Rev.," vol. xiv., p. 213; "Lond. Med. Gaz.," vol. ii., p. 669.)	Double usual premiums had been taken, but he had previously had cerebral symptoms, and died of tumour of brain, &c.
Executors of Earl of Mar *v.* Edinburgh Life Assurance Company.	£3,000	That he was an opium-eater, and had concealed it.	Jury Court, Edinburgh, 1830.	Verdict for plaintiffs, agreeable to Commissioner's summing up.	Verdict chiefly on the ground that the Company were not careful enough in making inquiries.
Geach *v.* Ingall.	—	Concealment of phthisis.	Warwick Summer Assizes, 1844.	Verdict for plaintiff.	Chiefly because the Company's medical officer had examined him.
Case of Mrs. Elgie, died in April, 1824.	—	Concealment of phthisis.	Two trials.	Verdict for plaintiffs.	Jury thought the concealment had not been material. Medical evidence conflicting.
Hernia (case mentioned by Dr. Taylor, *loc. cit.* vol. ii., p. 617).	—	Alleged concealment of hernia, or at least of a scrotal tumour. Died 13 months after insurance of strangulated hernia.	Two trials.	Verdict for plaintiffs on second trial.	Medical evidence conflicting.
Maynard *v.* Rhode and others, Pelican Life Office. Colonel Lyon's case. (Dr. Taylor, *loc. cit.* vol. ii., p. 617.)	—	Concealment of a previous illness, and of name of previous medical attendant.	Trial before Lord Tenterden, 1823 or 1824.	Verdict for defendants.	A similar issue raised collaterally in *Jay's* case, q. v.
Wilshere *v.* Brown.	—	Concealment of previous illness, and denial that he had any medical attendant.	Exchequer, Dec., 1842, before Lord Abinger.	Verdict for defendants.	On the ground of fraud.
Palmer and Fish *v.* Irving. (On life of one Howes.)	£1,500	Concealment of previous illness. Denied having had a doctor, whilst three had attended him	Norwich Summer Assizes, 1842 (?).	Verdict for defendants.	On the ground of fraud.
(An Insurance Company.) —— *v.* Executors of Mrs. Ralston.	See Taylor, *loc. cit.* vol. ii., p. 618.	Concealment of epileptic fits, &c.	Glasgow, 1837.	Verdict for the Life Office.	On the ground of want of candour.
Brembridge *v.* Hoare. (From Sun Life Insurance Co.)	£5,000, on the life of Mrs. Formby.	Concealment of laceration of perinæum, and of uterine disease and displacement.	Court of Exchequer, Feb., 1873. (Baron Bramwell.)	Verdict for Life Office (*i.e.* for defendants).	The case is curious in itself. The medical evidence is voluminous. (See Taylor, *loc. cit.* vol. ii., pp. 619—621.)

Names of Plaintiffs and Defendants.	Amount Insured.	Reasons given for disputing.	Date of Action.	Verdict.	Remarks.
Leete *v.* The Gresham Life Office.	£350, on life of Giles Clement.	Concealment of urinary and prostatic disease existing from boyhood.	Court of Exchequer, July, 1851.	Verdict for defendants.	No medical evidence for plaintiffs.
Southcomb *v.* Merriman.	—	Intemperance of assured.	Exeter Spring Assizes, 1842.	Verdict for plaintiffs, but a rule for new trial obtained.	Twelve witnesses proved him to have been very temperate; 21 that he was the reverse!
Wiggins *v.* Gresham Life Office.	—	Intemperance, and suppression of disease of lungs.	Bristol Summer Assizes, 1872.	Verdict for the Office.	On the ground of suppression of material facts.
Baily *v.* Imperial Assurance Company.	£300	Alleged concealment of phthisical symptoms.	Oxford Circ., July, 1869.	Verdict against Office.	Chiefly on ground that their own examining medical man failed to recognise symptoms of phthisis.
Craig *v.* Fenn. (Case of Hon. H. G. Talbot.)	—	On the ground of intemperance being concealed.	Dec., 1841.	Verdict for Office.	No answer being returned to question as to temperate habits, the Office charged a higher premium; but it was held that the habits of deceased ought to have been told them.
Hutton *v.* Waterloo Life Association. (Action by widow.)	£2,500	Concealed intemperate habits. Alleged concealment of *delirium tremens.*	Queen's Bench, Dec., 1859.	Verdict mainly for defendants.	Company's own medical man described him as a "first-class" life.
Wheelton *v.* Hurdisty. (Life of Mr. Jodrell.)	A large amount.	Concealment of intemperate habits and of *delirium tremens.*	Queen's Bench, Dec., 1856.	Verdict for defendants.	Company's own medical examiner certified him as a "first-class" life.
Rawlings *v.* Desborough. (Life of John Cochrane.)	£4,000	Concealed habits of intemperance.	Queen's Bench, before Lord Denman, Dec., 1837.	Verdict for plaintiff: a motion for new trial made soon after.	The life had been declined by Mr. Travers for one office on ground of *delirium tremens.* Lord Denman said a proposed insurer was not bound to volunteer statements of all sorts of things; but he was bound to conceal nothing when asked, and to answer all questions truly.
Pole *v.* Rogers. (On life of Peter Cochrane.)	—	Concealed intemperance, alleged to be the cause of hydrothorax, of which he died.	Before C. J. Tindal, Feb., 1840.	Verdict for plaintiff.	See remarks of Solicitor-General. Taylor (*loc. cit.* vol. ii., p. 625).
Chattock *v.* Shawe. (Life of Col. Greswold.) Eagle Office.	£5,000	Alleged concealment of intemperance and *delirium tremens.*	Exchequer, July, 1835.	Verdict for plaintiff.	Curious medical evidence as to cause of death. Taylor (*loc. cit. supra*).
Walters *v.* Barker.	—	Concealment of *paralysis*, alleged to have existed from a very early age.	Monmouth Summer Assizes, 1844.	Verdict for plaintiff.	No medical evidence.
French case, in which there had been hemiplegia ten years from apoplexy, and death from the latter disease. The Sieur Fried (residing at Strasburg).	—	Concealment of hemiplegia.	—	Conflicting opinions given by the medical referees concerned in the case.	See Tardieu (*loc. cit.*) and Ristelhueber's "Rapports et Consultations de Médecine légale."

Names of Plaintiffs and Defendants.	Amount Insured.	Reasons given for disputing.	Date of Action.	Verdict.	Remarks.
Huntley *v.* the St. George Insurance Company. (Insurer was a medical man, and died three months after insurance.)	£2,000	Concealment of Bright's disease. and of diseased heart. Vegetarianism supposed to have caused his ill-health.	Newcastle Autumn Assizes, 1858.	Verdict for plaintiff.	The Lord Chief Baron suggested that in future Insurance Companies should ask intending assurers, "Are you a vegetarian?" !!
Executors of a Clergyman *v.* Providence Insurance Company.	—	Concealment of fact of insanity.	York Assizes, 1835.	Verdict for plaintiffs.	The jury found that insanity had no tendency to shorten life: a verdict entirely against medical experience and known facts.
Sinclair *v.* the Maritime Insurance Company. (Life of a Capt. Lawrence.)	—	On the ground that "sunstroke" was not an accident.	Court of Queen's Bench, Jan., 1861.	Verdict for defendants.	On the ground that "sunstroke" was a *natural* cause of death. (We think this verdict fairly open to question. In our opinion the suddenness constitutes a part of the accidental nature.)
Cross *v.* the Railway Accident Insurance Company.	£500	On the ground that, although she fell downstairs, and was never well again, she died from disease, and not accident.	Lewes Summer Assizes, 1871.	Verdict for defendants, except £30 paid into Court.	Medical evidence conflicting. It was deposed that she had Bright's disease and dropsy.
Kinnear *v.* the Rock Insurance Company.	£10,000	Probable suicide from narcotic poisoning.	Before Lord Tenterden, in 1832.	Verdict for plaintiff.	Suicide not proved. (See Taylor, *loc. cit.* vol. ii., pp. 634—638.)
Hebdon *v.* West. (On life of a Mr. Pedder.)	£2,500	Defendant contended that plaintiff had no insurable interest in the life of Pedder.	—	The Court reserved its judgment.	See next case of Wainwright.
Wainwright *v.* Bland. (Insurance on the life of a Miss Abercrombie in the Imperial Assurance Company.	£18,000, in five offices, (in time policies for two or three years).	On the ground that the death probably arose from poison, misrepresentation, and want of interest.	Exchequer, June, 1835.	Lord Abinger pointed out the direct interest the insurer had in her death.	Wainwright was afterwards transported for forgery, and died of apoplexy. He is said to have confessed that he gave strychnine to Miss Abercrombie and to two others.
Regina *v.* Palmer, 1856.	Palmer had effected insurances to the amount of many thousands	Payment not disputed, though some of the proposals were declined.	Central Criminal Court, May, 1856.	The brother's life also was insured for £23,000.	See the journals (medical and others of the time), and Taylor, *loc. cit.* vol. i., p. 405; vol. ii., p. 612, &c.
Regina *v.* Cotton (for murder of her step-son by arsenic).	This woman had insured nearly 20 lives in different offices.	She was said to have killed twenty persons in all, one after another.	Durham Lent Assizes, 1873.	—	See remarks by Dr. Taylor, *loc. cit.* p. 645.
Borrodaile *v.* Hunter and others. (Rev. W. B. Borrodaile.)	£1,000	Suicide (?) of insurer, who was seen to go into the water.	Common Pleas, Dec., 1841.	Judgment for plaintiff, but reversed afterwards.	
Evans *v.* Cox. (British Com-	£2,500, also £700	Concealment of intemperate habits,	King's Bench,	Verdict for plaintiff, but	

Names of Plaintiffs and Defendants.	Amount Insured.	Reasons given for disputing.	Date of Action.	Verdict.	Remarks.
mercial Life Office.) Life of Ann Elsworthy.	in Globe.	and of previous cholera.	Feb., 1831.	Lord Tenterden granted a fresh trial.	
Lefevre *v.* Boyd. (Two brothers named Edwards, induced Jane Lydia Simpson, their half-sister, to insure her life.	£832 1 6 but a much larger sum insured.	Concealment of pregnancy, and of birth of child, who died with symptoms of syphilis, aged two months.	King's Bench, 1831. (Dr. Paris examined.) Medical evidence that the pregnancy was material under the circumstances.	Verdict for plaintiff (*i. e.*, for Office).	She was pregnant by W. Reid Edwards, her half-brother !
Ross *v.* Bradshaw. (Case of Sir James Ross, wounded in loins in battle of La Feldt in 1747.)	Insured for one year, and a warranty given.	Alleged fraud in concealing partial paralysis and incontinence of urine, &c.	See 1 Bl. 312, before Lord Mansfield.	Verdict for plaintiff, because a warranty had been given. No fraud proved.	Had incontinence of urine and fæces, which was not mentioned.
Willis *v.* Poole. (Life of Sir Simeon Sturt.)	—	Concealment of gout.	Before Lord Mansfield.	Verdict for plaintiff (*i.e.*, against Office).	Lord Mansfield said: "Such a warranty can never mean that a man has not in him the seeds of some disorder. We are all born with the seeds of mortality in us. A man subject to the gout is a life capable of being insured if he has no sickness at the time to make it an unequal contract."

Other Cases of Disputed Claims on Life Offices.

Jay v. *Gresham Life Asurance Company* [mentioned page 627], Leeds Assizes, August 1874, before Mr. Baron Amphlett [£3000]. Verdict for plaintiffs.

Beake (executrix) v. *Nicholson and Others* (Universal Life Insurance Company). Tried before Mr. Baron Pigott, to recover £1000 insured. Verdict for plaintiff for full amount. Rule *nisi* obtained and afterwards rule absolute for new trial. Disputed by the Universal on the ground that the insurer died by his own hands. Widow contended that he was under an insane delusion, so as not to know what he was doing, or what would be the consequence of his act. [He came by his death by throwing himself in the way of a passing engine and train at Battersea Station.]

Case related by M. Tardieu (Ann. d'Hygiène, 1866, 2, p. 410), of Johann Peter Hoffstedt, insured in a French office. Had tried to hang himself. The man who assured his life agreed to give him spirits, *ad lib.*, if he took no other nourishment. This man, it was supposed, gave Hoffstedt arsenic—but suicide was suggested. Decided in favour of office.

Case related by Dr. Taylor of a man found dead from pistol shots, probably murdered by a medical man who had insured his life heavily. *Loc. cit.* vol. i., p. 672, vol. ii., p. 640.

Dr. De la Pommerais' case. He insured the life of a woman named *Pauw* for £22,000, and then poisoned her with digitalis. [Consult Tardieu. "Somnenschein" (*loc. cit.*), p. 209, &c. ; and the article *Digitalis* in this work, p. 405, where other references are given.]

See, also, "Jones on Annuities," Library of Useful Knowledge, Vol. II. (1844).

The case of *Edmonds* v. *The Prudential Life Office* (note to page 612).

When you have carefully examined a "life," you will, perhaps, have discovered signs of disease, or deviations from the normal standard. Should these be considerable, the life must be taken as a diseased one. You will, however, in most offices, be asked our second question. "How many years added to the age of the proposed insurer will cover the extra risks?" On this point much must be left to the individual judgment. Dr. Sieveking's remarks on this (*loc. cit.*, p. 53) are, however, extremely pertinent and just. He says, "At present the suggestions offered by gentlemen of limited experience often show that they by no means appreciate the real question at issue, inasmuch as they state circumstances that materially affect the applicant's liability, and suggest additions to the tabular rate quite incommensurate with the manifestly increased risk to the office. Three or four years' addition is often recommended by medical men, when nothing less than ten or fifteen would cover the individual risk. What should be considered is, how much is a disease or defect in the family history of an individual likely to diminish his average longevity as compared with a person without such a flaw in his antecedents. If the life is 30, and the answer is 10 years, the addition should be 15 years extra, *i.e.*, the expectation is 34½ at 30, and 24½ at 45, and the addition should be the difference between 30 and 45, or 15. For these purposes, Mr. Milne's table subjoined, is usually taken.

The average duration of life from 1 to 80 years of age, according to the Carlisle mortality :—

Years old.	Expectancy.	Years old.	Expectancy.	Years old.	Expectancy.	Years old.	Expectancy.	Years old.	Expectancy.	Years old.	Expectancy.
	Years.		Years.		Years.		Years.		Years.		Years.
Birth.	38¾	14	45¾	28	35¾	42	20¼	55	17¾	68	10¼
1	44¾	15	45	29	35	43	25¾	56	17	69	9¾
2	47½	16	44¼	30	34½	44	25¼	57	16¼	70	9¼
3	50	17	43½	31	33¾	45	24½	58	15½	71	8¾
4	50¾	18	43	32	33	46	24	59	15	72	8¼
5	51¼	19	42¼	33	32½	47	23¼	60	14½	73	7¾
6	51¼	20	41½	34	31¾	48	22½	61	14	74	7¼
7	51	21	40¾	35	31	49	22	62	13½	75	7
8	50¼	22	40	36	30¼	50	21¼	63	13	76	6¾
9	49¾	23	39½	37	29¾	51	20½	64	12½	77	6½
10	49	24	38¾	38	29	52	19¾	65	11¾	78	6¼
11	48	25	38	39	28¼	53	19	66	11¼	79	5¾
12	47¼	26	37¼	40	27¾	54	18¼	67	10¾	80	5½
13	46½	27	36½	41	27						

MODES OF DEATH, OR MANNER OF DYING.

Sudden Death.

Both as regards life assurance, and in other medico-legal inquiries, very great importance is justly attributed to the mode of dying. The medical witness, who has made a careful post-mortem examination, is often able, from this alone, to exclude certain diseases and accidents, and to state, with extreme probability, that death has, or has not occurred, from certain specified causes. Even from the statements of those who were present at the death, or just before or after, similar conclusions can often be drawn, when the body has not been opened, though with far less certainty. We may remark here, that to hold an inquest without making a post-mortem examination, is in most instances to leave the most important witness unexamined.* Bichat,† who, as a physiologist, is scarcely second to any, except perhaps Haller and the Hunters, was one of the first to draw attention to this point. He spoke of death beginning at the *head*, death beginning at the *heart*, and death beginning at the *lungs*. In spite of many adverse criticisms, this division is one of the best, although some modifications and sub-divisions must be made to adapt it to modern views and increased knowledge of the nervous system.

Those who wish to get a deeper insight into this can scarcely do better than read the eloquent chapter in Dr. Watson's "Principles and Practice of Physic" (Lecture V., vol. i., pp. 59—75), in which he discusses this subject. For the purpose, however, of assisting your judgment and memory, we will give a brief summary of these three modes of dying.

I. *Death beginning at the head, or death by coma.* In this there is stupor, more or less profound; external impressions appear to be no longer recognised by the dying man, or are recognised but feebly; this loss of sensibility and consciousness deepens into death. The breathing becomes slow, irregular, and noisy (stertorous), and all voluntary control over respiration is lost. Yet for a time this function is imperfectly carried on; at last this fails also, and the chest is no longer expanded, the blood is no longer aërated, and the post-mortem appearances in the thorax differ but slightly from those in death beginning at the lungs (death by apnœa and asphyxia). This is the mode of death in most cases of injuries and diseases of the brain [*e.g.*, compression, apoplexy, hydrocephalus]; in poisoning by narcotics [opium, and most of the vegetable alkaloids]; in some cases of mineral poisons [barium, arsenic, &c.]; and in some cases of kidney and liver-disease [uræmic poisoning].

Mr. Whateley ["Medical Observations and Inquiries," vol. vi.], quoted by Dr. Watson, mentions a case in which *artificial respiration* proved successful in restoring a patient who had swallowed a large quantity of opium. Sir Benjamin Brodie proved the same in animals poisoned by woorara. And the authors have resorted to the same expedient in some cases of eclampsia.

II. *Death beginning at the heart.* When there is a want of due blood-supply to the heart, we get what is called death by *anæmia.* This is the mode of death in uterine and other hæmorrhages. If an animal be killed in this way (*i.e.*, by *depletion*), and the heart be quickly examined, it is found to be *contracted.* In other words, it has gone on working, and only stops at last because no more blood comes to it. The results of transfusion of blood, of saline injections into the veins, and the effect of stimulants and nourishment in a fluid form, may be regarded as experiments in a reverse direction, but proving the same thing. In this mode of death we get "a mortal paleness in the cheek," especially seen in the lips, which may be slightly dusky in some. There are cold sweats, dimness of vision, dilated pupils, vertigo (or giddiness), a slow, weak, irregular, or fluttering pulse, and insensibility soon sets in. There may also be nausea, or even vomiting, restless movements of the limbs (jactitation), transient delirium, frequent hallucinations of the sense of hearing, with flashes of light before the eyes; the breathing is irregular, with sighing, and at last gasping: there may be hiccup; convulsions generally come on, and may be repeated once or twice before death. This mode of death, besides occurring in obstetric practice, and on the battle-field, and in accidents where much blood is lost, may occur from the sudden rupture of an aneurism. As regards this, it is proper to mention that very large losses of blood, whether external or internal, sometimes prove as suddenly fatal as any shot from a pistol could be.

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* "He, being dead, yet speaketh."—Heb. xi., 4.

† "Recherches sur la Vie et la Mort," par Marie François Xavier Bichat, Paris, 1800.

There is another mode of death, said to begin at the heart, termed *death by asthenia.* In this kind of death, the heart's cavities are not contracted, but either more or less full of blood, or if empty, dilated and flabby. The former was the case in Sir B. Brodie's experiments on poisoning by the *upas antiar.* When death by asthenia, from want of power or debility of the heart, occurs from *starvation*, or from exhausting and lingering disorders (such as phthisis, diabetes, dysentery, cancer, especially that of the stomach or œsophagus, tumours pressing on the thoracic duct, and the like), the pulse becomes very feeble and frequent, and muscular weakness is extreme, but the senses retain their full activity; sometimes, as Dr. Watson says, they are even painfully acute, and the intellect remains clear to the last.

This distinguishes *collapse* (especially abdominal collapse), from concussion, and from syncope, in which consciousness is temporarily lost. Asiatic cholera in the algide stage often furnishes striking examples of this; patients supposed to be dead hearing every whisper of those around them, and manifesting consciousness by signs when unable to speak even in a whisper. The hands and feet, and surface generally, are cold; and the circulation in the extremities is arrested first, so that the fingers, lips, nose, and ears, are often livid.

Death by *syncope* or fainting, and death by *shock*, are modifications of these two modes of dying (by anæmia, and by asthenia), and present characters common to both, as pointed out by Dr. Watson. In syncope and in anæmia generally, the tendency to death can sometimes be arrested by mere position—thus, in bleeding for medical purposes, as Dr. Marshall Hall pointed out, the patient should be bled while sitting, so as to be laid down the moment symptoms of faintness come on. The loss of large quantities of fluid, as in tapping for ascites, or even the emptying of a large hydrocele, and emptying the bladder by a catheter when much distended, have been known to produce syncope and death. Mrs. Garrett Anderson's supposed case of "clotting in the heart," was almost certainly an instance of this. If possible, therefore, patients should be tapped in bed, sitting up, and the effects on the pulse should be watched. Sudden deaths from what is called *shock*, including mental emotion (either great joy or great grief, or great terror), fatal concussion, blows in the epigastrum, lightning and electricity, and some suddenly fatal forms of apoplexy, are probably all produced in a somewhat similar manner. They probably all act through the *nervous system*, either on the cardiac ganglia of the sympathetic nerve, or on some other portions of that system, or upon certain definite tracks in the medulla oblongata, or the brain. The very mention of these subjects will show the difficulties which occur to the system-monger, and will convince you that none but those familiar both with clinical and dead-house work, and with the records of medicine, are competent to give an opinion as to the cause of death, in any case whatever.

III. *Death beginning at the lungs*, death by *apnœa*, or, as it is commonly called, by *asphyxia*. Dr. Watson and other medical writers have striven to banish the use of the latter word, which should signify pulselessness, or the want of a pulse, from descriptions of death by drowning, hanging, or other forms of suffocation. Hitherto their efforts have been vain. As the post-mortem appearances will be found at some length in the chapter on modes of death by apnœa (hanging, drowning, and the like), it is not necessary to do more here than just to remind you of the gorged state of the lungs and venous system generally, and of the right heart in particular. Anything which prevents the entrance of air into, or the exit of air from the lungs will produce this kind of death. Paralysis of the muscles of respiration, or of the nervous centres for that act, the presence of fluid (even of air itself, in the pleural cavities), and many poisons) notably carbon dioxide and hydrocyanic acid), produce death with similar symptoms in life [sense of suffocation, struggles to breathe, vertigo, general convulsions, with loss of consciousness, and relaxation of sphincters], and the same, or very similar, post-mortem appearances [described above].

You will, from a careful study of these three great classes, draw the conclusion that a very large number of deaths may be referred to the *nervous system*, and so our first division might be widened by saying instead of *head*, death beginning at the nervous system. You see, too, that the lungs are the point of danger in death by coma—that some forms of death are, or might be, included, in all three classes—and you might at first be tempted to draw the conclusion that any study of the causes of death was lost time. To do so would be very rash. For example, the condition of the right heart and lungs in Class III. will enable you positively to state that death did not occur by syncope. And again, if you found a large clot of blood in the lateral ventricles of the brain, although poison might *possibly* have been taken as well, or fatal violence have been employed towards the deceased, yet a sufficient natural cause of death has been discovered, and nothing but positive proofs of the poison or violence ought to be admitted as material evidence in such a case.

Sudden Deaths.

A few words must be added on the subject of *sudden deaths*. A few years ago it used to be said that all sudden deaths (except such as were due to violence or poisons like prussic acid) were deaths from diseased heart. Many coroners, even now, and some medical men, appear to think that a post-mortem examination is unnecessary in cases where a person is seen to die suddenly, without being shot, or stabbed, or taking poison! We owe to Dr. Francis Ogston, of Aberdeen,* a great obligation for pointing out the large number of causes of sudden death which are revealed by post-mortem examination.

Amongst the common causes of sudden death (excluding violence and poison) we may mention :—

1. Diseases of the heart, especially fatty and brown degeneration, angina pectoris, aortic regurgitation, interstitial abscess, rupture of the heart, or of its valves, and diseases of the pericardium.
2. Diseases of blood-vessels, especially aneurism and thrombosis; the aneurisms most likely to end thus suddenly are intra-cranial, intra-pericardial, abdominal, and pulmonary.
3. Large effusions of blood in the brain or its membranes, apoplexy, and meningeal apoplexy.
4. Pulmonary apoplexy, and hæmatothorax.
5. The sudden bursting of visceral abscesses, as in the liver, brain, &c.
6. Ulcers of the stomach, duodenum, or other parts of the alimentary canal.
7. Extra-uterine fœtation, peri- and retro-uterine hæmatoceles, apoplexy of the ovary, rupture of the uterus.
8. Rupture of the urinary or gall-bladder, or of some other viscus, from accidental violence.
9. Cholera, and some zymotic diseases, kill very rapidly.
10. Large draughts of cold water when heated (large quantities of spirits come under the head of alcoholic poisoning).
11. Mental emotions (fear, grief, joy).
12. Foreign bodies accidentally swallowed, *e.g.*, a large bit of meat may be found blocking the pharynx, and obstructing the glottis.

Dr. Guy (loc. cit. p. 252) quotes Ferrario and Sormoni on sudden deaths occurring in Milan, as follows :—

Of 1,048 sudden deaths, 879, or about 4 in 5, were from the *Head* (including apoplexy, cerebral concussion, vertigo, and coma); 150, or about 1 in 7, were from the *Heart* (including heart diseases, angina pectoris, aneurism, and hæmorrhage); 14, or about 1 in 75, were from the *Lungs* (including asphyxia, suffocative catarrh, and pulmonary apoplexy); whilst 5, or 1 in 210, were from difficult labours. These figures, of course, refer almost entirely to adults. In young children, Laryngismus stridulus (spasmodic croup), Atalectasis pulmonum, sudden collapse of lung (in capillary bronchitis), pneumonic consolidation, rapid serous effusions, particularly into the pleura, and pulmonary apoplexy, are chief causes, apart from suffocation, and scalds of the glottis. *See* Dr. Guy (*loc. cit.*, p. 253), and a lecture by Dr. West "On Sudden Death in Infant Children," Medical Times and Gazette, Nov. 26, 1859.

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* His papers will be found in the "British and Foreign Medico Chirurgical Review," vol. xliv., p. 452, &c.; and the Edinburgh Medical Journal (under various titles). He describes thrombosis of the heart and great vessels as present in 10 per cent. of his cases of sudden death. *See* also Beck (*loc. cit.*, p. 510), who gives numerous references, including Dr. Christison's paper on Latent Diseases in "Cyclopædia of Practical Medicine," vol. iv.; and Herrich and Kopp's "Der Plötzliche Tod aus inneren Ursachen." Regensburg, 1848. Quoted by Dr. Taylor, who also refers to M. Devergie [" Annales d' Hygiène," vol. ii., p. 145. 1838].

Nearly 1 per cent. of the cases of death certified to the Registrar-General may be considered as "sudden deaths," [3,843, or 1 in 109 for the five years 1852-56, besides the violent deaths. Upwards of one-third of these sudden deaths occur in infancy. For these figures we are indebted to Dr. Guy, *loc. cit.*, pp. 252 and 253].

CHAPTER XXI.

The limits of distinct vision—Audible sounds—Personal identity in the dead and in the living—Sex—Age—Personal appearance—Special marks.

Few subjects present so many difficulties to the medical jurist as that of personal identity. There are several reasons for this. We need only mention two or three. For instance, the fact that the great majority of witnesses are people not trained to minute observation, so that, in all good faith, they will swear to statements as to height, complexion, and habit of body, which involve discrepancies of a foot in height, of several stone in weight, and the inconsistency of the hair being both light and dark at the same time. Again the changes wrought by time in some people are far greater than is generally supposed. Criminals also are great adepts at personal disguisement; and in cases of assault, robbery, murder, and the like, it often happens that the criminal is only seen for a moment or two, perhaps by the light of the moon, or by that of a flash of lightning, or the flash of a pistol or other weapon. As this subject is pre-eminently one for experiment, it is much to be regretted that there are not more accurate observations on record. One of the first questions which arise is, What are the limits of normal vision or healthy sight, unassisted by instruments? As regards myopia or short sight, hypermetropia and presbyopia, and other varieties of imperfect sight, it is clear that these must either be assisted by lenses (spectacles); or else allowances must be made. The shape of the earth sets a certain limit to vision, even as regards very large and lofty objects, as will be seen from the following table (from Carr's "Synopsis of Practical Philosophy").

Table showing the distance in miles of the farthest visible point that can be seen from the top of a given height, taking into account the effect of refraction.

Height in Feet.	Distance in Miles.	Height in Feet.	Distance in Miles.	Height in Feet.	Distance in Miles.	Height in Feet.	Distance in Miles.
5	2·96	60	10·25	500	29·5	5,000	94·0
10	4·18	70	11·1	700	35·0	6,000	102·0
15	5·12	100	13·2	1,000	41·8	7,000	110·0
20	5·91	150	16·2	1,500	51·0	8,000	118·0
25	6·61	200	18·7	2,000	59·0	9,000	125·0
30	7·25	250	20·9	2,500	66·0	10,000	132·0
40	8·37	300	22·9	3,000	72·0	15,000	162·0
50	9·35	400	26·4	4,000	83·0	20,000	187·0

It follows from this, that a man of ordinary height can be seen on level ground at a distance of two to three miles on a clear day. This is, however, very different from *recognition* of the person, so as to secure personal identity. As regards the *smallest* objects recognisable by the unassisted sight, there has been much discrepancy of opinion. Carpenter states, apparently on the authority of Ehrenberg, that the smallest square magnitude, black or white, which can be seen alone, on a ground of the reverse colour, is about the $\frac{1}{405}$th to the $\frac{1}{540}$th of an inch. But particles which powerfully reflect the light, such as gold dust of $\frac{1}{1125}$th of an inch, could be seen with the naked eye in common daylight. The delicacy of vision is far greater for *lines* than for mere points, since opaque threads of $\frac{1}{4900}$th of an inch (about $\frac{1}{2}$ diameter of silk-worm's fibre) may be discerned by the naked eye when held towards the light. Bergmann found that black and white chequers of $\frac{1}{25}$th of an inch square could be discerned at such a distance, that the retinal image of each square could not have exceeded half the diameter of one of the cones of the bacillary layer (these cones are said to have a diameter of $\frac{1}{4166}$th of an inch). Volkmann (quoted in Funke's "Lehrbuch d. Physiologie") considered that parallel black lines could be seen when only $\frac{4}{1000}$th of a millimètre apart = $\frac{1}{6250}$th of an inch. Dr. Vincent De Guéret (of Creuse) in "La France Médicale," (No. 57, for 1875), states that objects to be seen at all must have a diameter of from $\frac{1}{6250}$th to $\frac{1}{5000}$th of an inch. One of the authors (who is myopic) can see the red corpuscles of sheep's blood, which are not more than $\frac{1}{5000}$th of an inch, when held up to a bright light, without any lenses. At a foot distance the object must be $\frac{1}{25}$th of an inch at least, to be seen—and the size must increase with the distance. Dr. De Guéret justly says that the following conditions must be present for the recognition of an object at the average distances given :—(1) Normal or emmetropic vision, or abnormalities must be compensated; (2) sufficient light; (3) sufficient size in the object. As regards the former, the eye must be normal as to colour, as well as in other respects. *Colour-blindness,* or *Daltonism,* has been the cause of many railway accidents, owing to the coloured lights or signals not being recognised. Even in war a red uniform has been confounded with a grey, and thus friends have been fired upon as if they had been foes, or foes not recognised.

The effect of age upon the acuteness of vision is considered by Dr. De Guéret to be, on an average, as follows :—

The acuteness of vision at	50	years is diminished	$\frac{1}{5}$*
,,	60	,,	$\frac{1}{4}$
,,	70	,,	$\frac{1}{3}$
,,	80	,,	$\frac{1}{2}$

In other words, if a man of forty could distinguish and recognise an object at 100 feet distance, at sixty years of age he could not recognise the same object further off than 75 feet. The recognition of persons seen at nearer or greater distances is by their *stature,* their *dress, gait,* or action, as regards the body; and as regards the head, its *shape,* whether round or oval face, colour and form of the *hair* or *head-dress,* such circumstances as *prognathism,* very prominent nose, &c.; the colour of the face, and at near distances, markings on it, the colour of the eyes, &c. From experiments on recognition, he concludes that the best known persons, even those possessing some personal peculiarities, can often be recognised only with difficulty in broad day-light at 100 mètres (328 feet, or a little over 109 yards). Beyond 150 mètres, or at 164 yards, this is perfectly impossible. Less known and less remarkable people may be recognised in broad day-light at 60 to 100 mètres (65 to 109 yards); people who have no personal peculiarities, and almost strangers at 25 to 30 mètres (27 to 33 yards); whilst those seen for the first time can only be recognised clearly (as to features, &c.) at from 15 to 20 mètres (= 16 to 22 yards). The best known person cannot be recognised farther off than 15 to 16 mètres (16 to 17 yards) by the clearest moonlight. The light of the moon is very variable. By star-light only, the best known person must not be further off than 3 to 4 mètres (10 to 13 feet).* The light of a *flash* of lightning enabled a lady, on her passage home from India, to see distinctly the features of a man who was robbing her trunk, in the cabin of a vessel on a very dark night. She was able next day to identify him. (Montgomery, "Cyclopædia of Practical Medicine," art. Identity, quoted by Guy.) You may be asked:—"Does the light given by the *flash* of a *pistol* or *gun* enable one to see clearly the face of the person firing, if seen for the first time?" In May 1808 the Sieur Labbé was riding along the high road with the widow Beaujean, when the servant of the former was wounded in the hand by a gun fired through a hedge bordered by a ditch. Both master and servant swore that they recognised the assassin by the light of the discharge (*see* Guy, *loc. cit.*, p. 7, and Taylor, *loc. cit.*, vol. i., p. 684). The accused, being sentenced to death on this evidence, appealed to the Court of Cassation, and many experiments were made by Guineau, Dupuis, Caussin, and others, which seemed to negative this possibility. The sentence was reversed. Fodéré afterwards contested this decision, and a subsequent case, confirmed by the experiments of Desgranges of Lyons, showed the possibility of such a recognition. Our own experiments force us to concur in the possibility of such recognitions in the majority of instances. In England, similar evidence has been received in several cases. In the first case (*Reg.* v. *White*, Croydon Autumn Assizes, 1839), the accused was acquitted. In *Reg.* v. *Stapley*, Lewes Lent Assizes, 1862, the evidence of a game-keeper, who identified his assailant by the flash of the gun, was received, and the prisoner convicted. In Paris and Fonblanque's case (*Rex.* v. *Haines*), the evidence of a police officer, who deposed that in 1799 a highwayman rode a dark-brown horse of remarkable head and shoulders, and had on a rough brown great coat, was received as satisfactory, though these facts were made out by the flash from his pistols. He stated that he had since identified the horse in a stable in London. Dr. Taylor also agrees in this possibility, but decides against the recognition of an assailant by the subjective sensation of flashes of light (vulgarly "seeing sparks") produced by a blow on the eyeball. He refers to Müller's "Physiology," and to Schilbach and Krügelstein in Henke's "Zeitschrift der S. A.," 1842, 1, 197, and 1845, 3, 172. In the present state of our knowledge, it is not possible to admit this evidence as of any scientific value, since such sensations are not uncommonly felt by those who are totally blind.

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* Donders and Snellen say $\frac{1}{10}$ only.

You may be asked questions as to *the distance at which sounds* (such as the report of a pistol or gun) *continue to be audible.* There are no data which enable us to give a precise answer. Very much would depend upon the direction of the wind, the amount of watery vapour in the atmosphere, the presence of other disturbing sounds, the intensity of the original noise, the configuration of the room, or surrounding country. The velocity of sound, according to Parry and Foster's experiments at Port Bowen, was 1035 feet per second at a temperature of 17·72° Fahrenheit (nine experiments). Lieutenant Kendall's experiments at a temperature of 9·14° Fahrenheit gave 1069·28 per second. But 1130 feet per second is often stated, on the authority of Millington and Lacaille. Flamstead and Halley gave 1142 feet per second. Mr. Goldingham's experiments at Madras gave an average of 1135 ; and he concludes that for each degree (Fahrenheit), of the thermometer 1·2 feet may be allowed in the velocity of sound for a second, for each degree of the hygrometer 1·4 feet, and for $\frac{1}{10}$th inch of the barometer 9·2 feet. He concludes that 10 feet per second is the difference of the velocity of sound between a calm, and in a moderate breeze; and 21¼ feet in a second, or 1275 in a minute, is the difference when the wind is in the direction of the motion of sound or opposed to it. ("Philosophical Transactions," 1823).

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* See also "De l'acuité de la vue pour les grandes distances," par le Dr. J. Gayet; "Annales d'oculistique," Sept.-Oct., 1875, p. 171.

This is about 13 miles a minute. Or 4½ seconds may be reckoned on an average for every mile.

Personal Identity in the dead and the living.

Notwithstanding its logical correctness, we doubt if any practical purpose be served by the separation of the question of personal identity into that of the dead and of the living, as has been done by Dr. Guy. It does not require a large amount of anatomical or medical knowledge to distinguish between those methods of examination which are possible in life, such as the determination of height and weight, and those which are only possible after death, such as the determination of the points and degree of ossification in a long bone. The principal means of identification are :—(1) Sex. (2) Age. (3) Stature. (4) Personal appearance, individual peculiarities and resemblances, markings and cicatrices. (4) Certain habits or gestures. (5) Handwriting. We will take these in order.

Discovery of Remains supposed to be Human.

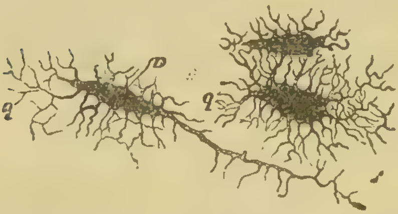
When either a whole skeleton, or portions only, are discovered, particularly when murder is suspected, these questions may be put to you :—

"Are these bones human? or those of some other animal?"

A similar question may be propounded as regards portions of skin or hair. As previously mentioned, the authors have seen human skin with hairs more than 1000 years old, in which, from the character of the hairs alone, there was no difficulty after microscopic examination, in answering this question in the affirmative, *i.e.*, in pronouncing it to be human. In this instance there were corroborative historical proofs. There can seldom be much difficulty if a whole skeleton be found ; for the skull, and the extremities of those (anthropoid) apes, the most like man, present important differences. Some of these animals, however, have clavicles, and their dental formulæ closely approximate to our own. Dr.

Taylor has devoted some space to a statement of the chief points of difference between the bones of other animals and of human beings. Some of these characters are not quite accurate; and for the rest, as our opinion is generally asked only on solitary bones, but little aid can be derived from so scanty an account. It is very easy to make mistakes when only fragments of bones are submitted to us. Even with whole bones, and complete skeletons, only those who have a competent knowledge of human osteology, and some acquaintance with the outlines of comparative anatomy, are competent to give an opinion. You may be asked whether chemical analysis or microscopic examination will help in the answer. It is undoubtedly true that the bones of old persons contain more calcareous and less animal matter than those of young persons, and hence look different under the microscope. It is also true that there are slight differences in the chemical composition of the bones of different animals, and Mr. Queckett ("Medical Gazette," Dec. 11, 1846), points out that the bone-cells (Fig. 57) bear a certain proportion in size to the blood-cells or blood-discs, being largest in reptiles, smallest in birds and mammals, and of an intermediate size in fishes. These are, however, only generalizations, and it would be very unsafe to apply them to particular instances in the present state of our knowledge. We can, however, have little difficulty, with the aid of the miscroscope, in settling the question whether the fragments submitted to us are bone or not, since even if Haversian canals and systems are absent, we shall find bone corpuscles or bone-cells like those in the figure. We therefore proceed to the question of—

FIG. 57.



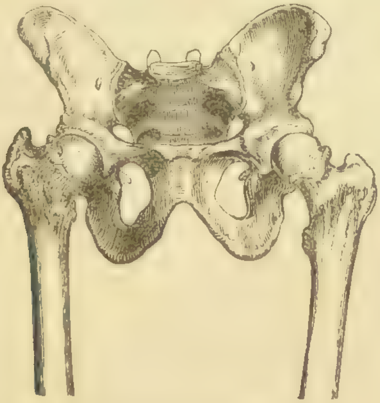
I. *The determination of personal identity by sex.* We must refer to the subsequent section on monsters, hermaphrodites, and sexual capacity, for information as to the sexual organs in doubtful cases. You will remember, too, that in an early chapter it was stated that the uterus in the human female resists decomposition in a very wonderful manner. The microscopic differences between male and female hairs have been given, pages 573-5. The general characters of the two sexes may be given thus:—*In the male* the shoulders should be broader than the hips, and the muscles are usually more developed in the male, hence the bones of a male present rougher and more prominent markings. In hard-working women the bones, however, are much marked. The male skeleton is heavier, and as a rule, the whole body exceeds in both height and weight (*see* tables, pp. 623-4), the pubic hairs extend higher towards the umbilicus in the male; the distance between the pubes and the navel is shorter in males, than between the navel and the scrobiculus cordis, or pit of the stomach; whilst the reverse is the case in females [Dr. Handyside]. The male has more hair on the body, less or rather shorter on the head. In the male the pomum Adami is more developed, and the larynx larger. The average male head is larger, and the brain heavier than in females. The blood is said to be richer in red corpuscles. *In the female* the hips are broader, the thighs shorter and bigger, and the tuberosities of the ischia and the acetabula are wider apart. The breasts [particularly the true breasts or mammary glands], are more developed. All these differences of course relate to adult males and females. Before puberty there is far less difference between the general characters of the sexes, although in the mass the male usually has the advantage of height, weight, &c., over the female. Common experience will show us that the voice is not a trustworthy mode of differentiation. It is said that "the female *skull* is smaller than the male, more ovoid, more bulging at the sides, and larger behind the foramen magnum, the face more oval, the frontal sinuses less strongly marked, the nostrils more delicate, the jaws and teeth smaller, and the chin less prominent. The *chest* of the female is deeper than that of the male [?], the sternum shorter and more convex; the ensiform cartilage thinner and ossified later in life; the ribs smaller, and the cartilages longer. The *vertebral column* is longer and the bodies of the vertebræ are deeper in the female than in the male" [Dr. Guy, *loc. cit.* p. 21]. As regards the clavicles, scapulæ, and bones of both upper and lower extremities, particularly the hands, those of the female are *generally* smaller and lighter than those of the male. Exceptions are, however, so numerous, that we can generally only be justified in stating that the bones are *probably* those of a female, unless we can examine the *pelvis*. We subjoin the

Differential Characters of the Male and Female Pelvis.

[Taken from Ward's "Osteology."]

The *male* pelvis presents a narrow deep, excavation with small apertures. Its bones are thick, its muscular impressions are well marked, its angles are abrupt and prominent, and its general appearance is that of a strong framework, adapted to afford leverage to powerful muscles.

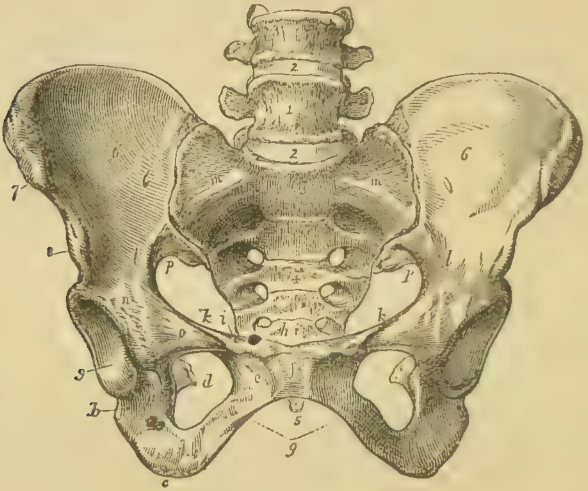
FIG. 58.



Male Pelvis, with thigh bones.

The *female* pelvis is not so deep as that of the male, but exceeds it considerably in the transverse, and antero-posterior dimensions. Its cavity is more capacious, its apertures are larger, its walls are less massive and rough, its general contour is less angular and abrupt. The alæ of the ossa innominata spread further outward; the anterior superior spinous processes are removed to a greater distance from the median line, as also are the tuberosities of the ischia and the acetabula, (whence the prominence of the hip of the female). The sacrum is wider, and less curved, and consequently the sacro-vertebral angle less prominent than in the male. The obturator or thyroid foramen is somewhat triangular in form, and of a smaller size than in the male; the ischiatic spines project less into the pelvic excavation; the coccyx is more moveable,* the symphysis pubis not so deep. The upper aperture is more nearly circular, and its margin smoother, and more rounded. The pubic arch is wider and more curved, and its rami are everted, so as to present shelving surfaces rather than angular edges, to any object descending through the perineal strait. By these several peculiarities of form and structure, the female pelvis is adapted to permit the expansion of the uterus during pregnancy, and the passage of the child in parturition. For special tables of pelvic measurements, both inside and out, we must refer to obstetric manuals. The following are, however, likely to be useful. They are from Meckel, Cloquet, Burns, and Ramsbotham.

FIG. 59.



Female Pelvis.

	Male.		Female.	
	Inches.	Lines.	Inches.	Lines.
Between the antero-superior spinous processes of the ilia . . .	7	8	8 to 10	6 0
Between the middle points of the cristæ of the ilia . . .	8	3	9 to 11	4 1

---

* During the last months of gestation the joints of the female pelvis acquire an increased mobility. This change is at first temporary, but after frequent child-bearing it becomes permanent. The coccyx is sometimes anchylosed to the sacrum by bony union, before childbirth, and thus becomes fractured.

		Male.		Female.	
		Inches.	Lines.	Inches.	Lines.
The transverse	diameter of the abdominal strait of the true pelvis	4	6	5 to 5	0 to 6
„ oblique		4	5	4 to 5	5 to 5
„ antero-posterior		4	0	4 to 4	0 to 4
The transverse	diameter of the cavity of the true pelvis	4	0	4 to 4	7 to 8
„ oblique		5	0	5 to 5	2 to 4
„ antero-posterior		5	0	4 to 4	7 to 8
The transverse	diameter of the perineal strait of the true pelvis	3	0	4 to 4	0 to 5
„ antero-posterior		3	3	4 to 5	4 to 0

The general characters in the two sexes will also be seen from these figures.

In the recent trial of *Wainwright* for the murder of *Harriet Lane*, the question of personal identity, as regards the body supposed to be that of the murdered woman, turned chiefly on the medical evidence as to whether the woman, whose body was found, had ever had a child or not. The medical evidence was somewhat conflicting. The *linœ albicantes* and purplish cicatrices found were somewhat indistinct, and as remarked in the chapter on pregnancy, might have been due to other causes. Then the question was raised. Is the uterus found that of a woman who has had children or not? The weight of medical testimony was in the affirmative, but at a subsequent discussion at the Obstetrical Society, it was admitted that the question was one of some difficulty. We must refer to the chapter on Pregnancy, and the section headed, "Has this woman been pregnant or not?" for figures and measurements of the uterus. For reports of the medical evidence in Wainwright's case *see* the medical journals passim, and especially the "British Medical Journal," December 11, 1875 (No. 780.)

II. *Age.* Personal identity naturally depends, in many cases, upon the *age* of the person concerned, or of the body or portions of a body discovered. It is often a matter of extreme difficulty to fix the age of living persons. The arts of the toilette will often render it difficult to do more than give an approximate guess. The teeth (*see* page 621) will often give us some idea of the period of life. If the hair have been dyed, it may, in the case of prisoners, be tested as mentioned in the chapter on hairs. In the case of children or young persons we can generally guess the age pretty fairly by means of the teeth, height, weight, and general development. It is, however, to be noted that some cases of congenital or *hereditary syphilis* exhibit a *retarded puberty*, and although their features look somewhat old, yet the general appearance of either sex at twenty-two or twenty-five may rather be that of ten or twelve or, at the most, fifteen years of age. Usually speaking it is the middle periods of life that give us most difficulty. Hard work, mental anxiety, and dissipation may make the man or woman of twenty-five or thirty, look forty or fifty ; whilst the absence of such causes may make others so "well preserved" as to look younger than their own children. It is a matter of common observation that grey hairs are not always a sign of age. But after thirty-five, besides the "crafty crowsfeet" about the eyes, of which the laureate speaks, there will be other lines about the face, especially around the mouth. The features are more set. The eye-lashes, eyebrows, and other hairs of the face grow coarser and longer. Hair often grows profusely in the nostrils and ears, particularly in the male sex. The thumbs become more pointed, the great toe turns outwards towards the middle line of the foot. The skin loses its suppleness, and becomes either dryer or more greasy. The body either emaciates or becomes much stouter. The abdomen, particularly in females, is often pendulous. The mammæ either waste or become very large. Hairs often grow about the nipples. The arteries may begin to grow cord-like, or even bony in hardness. The superficial ones are noticed to be tortuous. An "*arcus senilis,*" is noticed in the eye. The figure begins to stoop, the teeth decay, the nose and chin approximate, and old age creeps on in the "lean and slippered pantaloons." For a full description of these senile changes see a "Practical Treatise on the Diseases and Infirmities of Advanced Life," by Dr. Daniel Maclachlan, 1863. Yet it is still true in the eloquent words of Sir Walter Scott (quoted by Beck) that—

"Danger, long travel, want, and woe
Soon change the form that best we know ;
For deadly fear can time outgo,
  And blanch at once the hair :
Hard toil can roughen form and face,
And want can quench the eye's bright grace,
Nor does old age a wrinkle trace
  More deeply than despair."—*Marmion.*

In cases in which the remains of a fœtus, child or young person, are found, we can often fix the age within a few months or a year or two, by careful examination of the points of ossification and other signs of development.

Mr. G. W. Callender, in his lectures at the Royal College of Surgeons, gives the following measurements of the fœtus at different ages :—

Length of Fœtus in inches.	Age in weeks.	Age in days.
·12	3	7 to 14
·4	6	35 to 42
·5	7	42 to 49
·7	8	49 to 56
·9	9	56 to 63
1·1		
1·5	10	63 to 70
2·3	12 to 16	84 to 112
3·		
3·5		
3·7		
3·8		

Length of Fœtus in inches.	Age in weeks.	Age in days.
4·	16 to 20	112 to 140
4·3		
4·7		
6·5		
6·7		
7·		
9·	22 to 24	154 to 163
10·		

The following table of the development of the fœtus is drawn from a number of sources. It is sufficient to mention Dr. W. Carpenter, and Beaunis and Bouchard (quoted in Gray's "Anatomy." Edited by Mr. Holmes) :—

End of second week.—Formation of the amnion and umbilical vesicle. Chorda dorsalis, and medullary groove. Heart.

Beginning of third week.—The vitelline membrane has entirely disappeared. Protovertebral discs. First pharyngeal arch. Buccal depression. Primitive circulation.

End of third week.—The allantois and Wolffian body appear. The amnion is closed. Cerebral vesicles. Primitive ocular and auditory vesicles. Coalescence of the inferior maxillary protuberances. Liver. Formation of the three last pharyngeal arches.

Embryo of three to four weeks, has the form of a serpent ; is three to five lines in length ; its head is indicated by a swelling ; its caudal extremity (in which is seen a white line, indicating the continuation of the medulla spinalis), slender, and terminating in the umbilical cord ; the mouth indicated by a cleft, the eyes by two black points ; members begin to appear as nipple-like protuberances ; liver occupies the whole abdomen ; the bladder is very large ; the chorion is villous, but its villosities are still diffused over the whole surface.

Fifth week.—The primitive aorta divides into primitive aorta and pulmonary artery. Conduit of Miller and genital gland. Ossification of clavicle, and lower jaw. Cartilage of Meckel (from which the malleus and incus are formed).

Embryo of six weeks.—Its length from 7 to 10 lines : weight from 40 to 75 grains ; face distinct from cranium ; apertures of nose, mouth, eyes and ears, perceptible ; head distinct from thorax ; hands and forearms in the middle of the length, fingers distinct ; legs and feet situated near the anus ; clavicle and inferior maxillary bone present a point of ossification ; distinct umbilicus for attachment of cord, which, at this time, consists of the omphalo-meseraic vessels, of a portion of the urachus, of a part of the intestinal tube, and of filaments which represent the umbilical vessels. The placenta begins to be formed ; the chorion still separated from the amnion ; the umbilical vesicle very large. In the sixth week the pharyngeal clefts disappear. The vertebral column, primitive cranium, and ribs assume the cartilaginous condition. Posterior roots of the nerves. Membranes of the nervous centres. Bladder. Kidneys. Tongue. Larynx. Thyroid Gland. Germs of teeth. Genital tubercle and folds.

In the seventh week the muscles begin to be perceptible. Points of ossification of the ribs, scapula, shafts of humerus, femur, tibia, intermaxillary bone, palate, upper jaw (its first four points).

Embryo of two months (*eight weeks*).—Length from 16 to 19 lines ; weight 150 to 300 grains; elbows and arms detached from the trunk ; heels and knees also isolated ; rudiments of the nose and of the lips ; palpebral circle beginning to show itself ; clitoris or penis apparent ; anus marked by a dark spot ; rudiments of lungs, spleen and supra-renal capsules ; cæcum placed behind the umbilicus ; digestive canal withdrawn into the abdomen ; urachus visible ; osseous points in the frontal bone and in the ribs. Chorion commencing to touch the amnion at the point opposite the insertion of the placenta ; placenta begins to assume its regular form ; umbilical vessels commence twisting. *In the eighth and ninth weeks*, according to Beaunis and Bouchard, there is an appearance of interdigital clefts ; the capsule of the lens, and pupillary membrane ; completion of the interventricular and commencement of the interauricular septum. Salivary glands; the larynx begins to become cartilaginous. All the vertebral bodies are cartilaginous. Points of ossification from the ulna, radius, fibula and ilium. The two halves of the bony palate unite; sympathetic nerve; corpus striatum; pericardium; distinction between the ovary and testicle (?). Osseous nuclei of vertebral bodies and arches, vomer, malar bone, shafts of metacarpal and metatarsal bones, and phalanges; gall-bladder.

Embryo of three months.—Length 2 to 2½ inches; weight 1 to 1½ oz. troy = 480 to 720 grains; head voluminous; eyelids in contact by their free margin; membrana pupillaris visible; mouth closed; fingers completely separated; inferior extremities of greater length than rudimentary tail; clitoris and penis very long; thymus as well as supra renal capsules present; cæcum placed below the umbilicus; cerebrum 5 lines, cerebellum 4 lines; medulla oblongata 1½ line, and medulla spinalis ¾ of a line in diameter; two ventricles of heart distinct. The decidua reflexa and uterina in contact; funis contains umbilical vessels, and a little of the gelatine of Warthon; placenta completely isolated; umbilical vesicle, allantois and omphalomeseraic vessels have disappeared. In the third month the catilaginous arches on the dorsal region of the spine close. Points of ossification for the occipital, sphenoid, os unguis, nasal bones, squamous portion of temporal, and ischium. Orbital centre of superior maxillary bone. Commencement of formation of maxillary sinus; pons Varolii; fissure of Sylvius; mammary gland; epiglottis; union of testicle with the canals of the Wolffian body. Prostate.

Fœtus of four months.—Length 5 to 6 inches; weight 2½ to 3 oz.; skin rosy, tolerably dense; mouth very large and open; membrana pupillaris very evident; nails begin to appear; genital organs and sex distinct; cæcum placed near the right kidney; gall-bladder appearing; meconium in duodenum; cæcal valve visible; umbilicus placed near pubis; ossicles of ears ossified; points of ossification in superior part of sacrum and pubis; membrane forming at point of insertion of placenta or uterus; complete contact of chorion with amnion. [*In the fourth month.* "Corpus callosum; membranous lamina spinalis; cartilage of Eustachian tube; tympanic ring; fat in subcutaneous cellular tissue; tonsils; closure of genital furrow; formation of scrotum and prepuce." B. and B.]

Fœtus of five months.—Length 6 to 7 inches; weight 5 to 7 oz.; volume of head still comparatively great; nails very distinct; hair beginning to appear; skin without sebaceous covering; white substance in cerebellum; heart and kidneys very voluminous; cæcum situated at inferior part of right kidney; gall-bladder distinct; germs of permanent teeth appear; points of ossification in pubis and calcaneum; meconium has a yellowish green tint, and occupies commencement of large intestine. [*In the fifth month* osseous nuclei of axis and odontoid process; lateral points of first sacral vertebra; median points of second. Osseous points of lateral masses of ethmoid. Ossification of stapes and petrous bone. Sudoriferous glands. Glands of Brunner. Lymphatic glands. Commencement of limitation of uterus and vagina." B. and B.]

Fœtus of six months.—Length 9 to 10 inches; weight 1 lb. Skin presents some appearance of fibrous structure; eyelids still agglutinated, and membrana pupillaris remains; sacculi begin to appear in the colon; funis inserted a little above pubis; face of a purplish red; hair white or silvery; sebaceous covering (vernix caseosa) begins to present itself; meconium in large intestine; liver dark red; gall-bladder contains serous fluid, destitute of bitterness; testes near kidneys; points of ossification in four divisions of sternum; middle point at lower end of sternum. [*In the sixth month.* Points of ossification for anterior root of transverse process of seventh cervical vertebra; lateral points of second sacral vertebra; median points of third; the sacro-vertebral angle forms. Osseous points of the manubrium sterni, and of os calcis. The cerebral hemisphere covers the cerebellum. Papillæ of the skin. The free border of the nail projects from the corium of the dermis. Peyer's patches. The walls of the uterus thicken." B. and B.]

Fœtus of seven months.—Length 13 to 15 inches; weight 3 to 4 lb.; skin rosy, thick and fibrous; sebaceous covering appear; nails do not yet reach extremities of fingers; eyelids no longer adherent; membrana pupillaris disappearing; a point of ossification in the astragalus; meconium occupies nearly whole of large intestine; valvulæ conniventes appearing; cæcum in right iliac fossa; left lobe of liver nearly as large as right; gall-bladder contains bile; brain firmer; testicles farther off kidneys; middle point at a little below end of sternum. [*In the seventh month.* Additional osseous points of first sacral vertebra; lateral points of third, median ditto of fourth. First osseous point of body of sternum; Meckel's cartilage disappears; cerebral convolutions; island of Reil; tubercula quadrigemina. Testicle passes into vaginal process of peritoneum." B. and B.]

Fœtus of eight months.—Length 14 to 16 inches; weight 4 or 5 lbs. Vernix caseosa all over skin; nails reach extremities of fingers; membrana pupillaris becomes invisible during this month; a point of ossification in last vertebra of sacrum; no centre of ossification yet in cartilage of inferior extremity of femur; convolutions begin to appear in brain; testicles descend into internal ring; the middle point is nearer the umbilicus than the sternum. Additional points for the second sacral vertebra, and lateral points for the fifth.

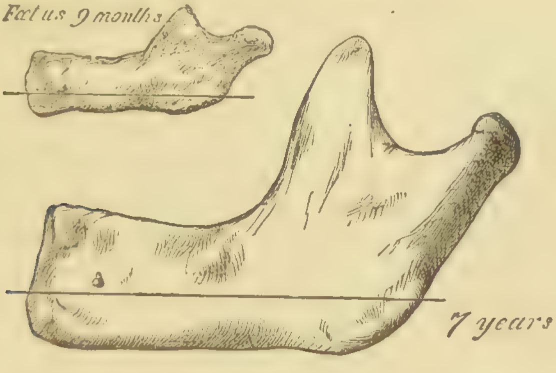
Fœtus of nine months (full term).—Length from 17 to 21 inches; weight from 5 to 9 lb; the average probably about 6½ lb; head more or less covered with hair, of from 9 to 12 lines in length; skin, especially at heads of joints, still covered with sebaceous matter; membrana papillaris gone; external auditory meatus still cartilaginous; four portions of occipital bone still remain distinct; os hyoides not ossified yet; point of ossification in the centre of cartilage at lower extremity of femur; white and grey matter of brain become distinct; liver reaches umbilicus; the testes have passed the inguinal ring, and are often found in the scrotum; meconium in rectum or at least sigmoid flexure; the middle point of the body at umbilicus or a little below it. [*In the ninth month.* "Additional points for the third sacral vertebra; lateral points for the fifth. Osseous point for the middle turbinated bone; for body and great cornu of the hyoid; for the second and third pieces of the body of the sternum; ossification of the bony lamina spiralis and axis of the cochlea. Opening of the eyelids." B. and B.]

Exceptions occur to most of the facts in the tables, as we shall have to mention in the chapter on Infanticide. These exceptions will usually be found to consist in backwardness of development.

Points of Ossification—Wormian and Sesamoid Bones.

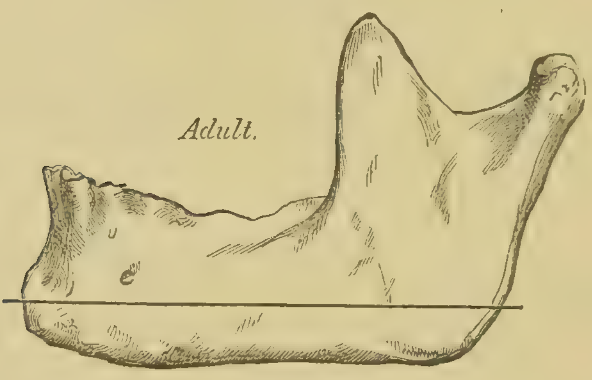
Great stress is justly laid upon the points of ossification in the cartilage of different bones, and upon the period at which this process is completed. For minute details reference must be made to special works and papers on Anatomy and Osteology, and the development of the fœtus. Amongst the former Hyrtl, Cloquet, and Quain and Sharpey, may be mentioned. The latter are too numerous to particularize. In addition to the facts mentioned in the table, the following facts regarding ossification are mentioned by Dr. Taylor as deserving special mention (*loc. cit.* p. 148, vol. i.).

FIG. 60.



At *one year* of age, ossification begins in the lower extremities of the humerus and ulna, in the heads of the femur and humerus, and in the upper cartilage of the tibia; at *one and a half* year the anterior fontanella should be closed; at *two years*, ossification takes place in the lower cartilage of the radius, and in the tibia and fibula; at *two and a half years*, in the greater tuberosity of the head of the humerus, in the patella, and in the lower ends of the four last metacarpal bones; at *three years* in the trochanters; at *four years* in the second and third cuneiform bones of the tarsus; at *four and a half years* in the small tuberosity of the head of the humerus, and the upper cartilage of the fibula; at *six years* the descending ramus of the pubis meets the ascending ramus of the ischium; at *from eight to nine years* the upper cartilage of the radius becomes ossified; at *nine years* the ilium, ischium and pubis meet in the cotyloid cavity (acetabulum) to form the pelvis; at *ten years* ossification begins in the cartilaginous end of the olecranon; at *twelve years* in the pisiform bone of the carpus; at *thirteen*, the three portions of the os innominata (ilium, ischium, and pubis), though nearly united, can be separated; the neck of the femur is ossified; at *fourteen*, or about puberty, there are added some fourteen additional centres to the sacrum; at *fifteen years*, the coracoid process is united to the scapula; and between *fifteen and sixteen* the olecranon to the ulna. From *eighteen to twenty years* the epiphysis at the upper end of the thigh bone is joined to the body of the thigh bone; as well as those belonging to the metacarpus, metatarsus, and phalanges. At *twenty* the upper and lower epiphyses of the fibula, as well as the lower epiphysis of the femur, are respectively united to the bones. At *twenty-five years* the epiphysis of the sternal end of the clavicle, and of the crista ilii are united to the bones. The epiphyses of the bodies of the vertebræ are sometimes not consolidated until thirty years of age. If all the epiphyses are united to their bones, if the bones are solid, and well-marked as to muscles and foramina, if the jaws show the wisdom-teeth, we may conclude the individual to be of adult age. The lower jaw undergoes remarkable changes with advancing age, which can best be understood by the figures, for which we are indebted to Tomes' Dental Surgery, Figs. 60, 61, 62.

FIG. 61.



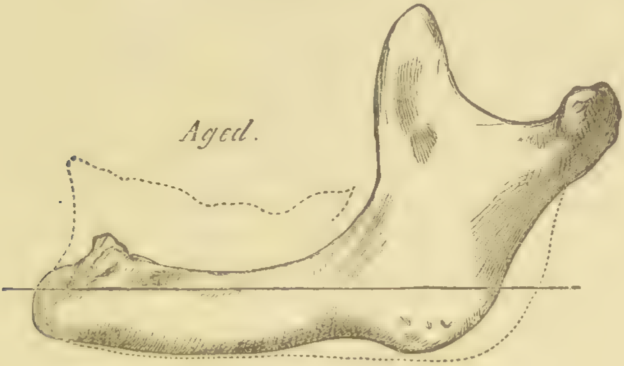
The neck of the *femur before puberty* is directed obliquely, so as to form a gentle curve from the axis of the shaft. In the *adult* male it forms an obtuse angle with the shaft, being directed upwards, inwards, and a little forwards. In the *female* it approaches more nearly a right angle. Occasionally in very *old* subjects, and more especially in those greatly debilitated, its direction becomes horizontal, so that the head sinks below the level of the trochanter, and its length diminishes to such a degree that the head becomes almost continuous with the shaft.

The two halves of the *frontal* bone are sometimes, although very rarely, separate all through life. The second and third pieces of the sternum are rarely joined until the thirty-fifth or fortieth years—the first and second rarely till very advanced life.

The cartilages of the ribs generally ossify quite late in life. Dr. Humphry regards this as rather a sign of disease than of age—in the first cartilage most often, more frequently in men, and at an earlier period of life than in women. It has previously been said that old bones have more mineral (earthy) matter than young ones, and are generally lighter from the medullary canals being larger.

The sutures of the skull become very firmly ossified, and numerous small bones (called *Ossa Wormiana*, or *Wormian bones*) are found in them.

FIG. 62.



In active persons numerous small bones (*sesamoid bones*) are formed in the tendons of the muscles. These are said to be more common, and more numerous in the male than in the female. There are two principal kinds: (1) those which glide over the articular surfaces of joints; and (2) those which ply over the cartilaginous facets found on the surfaces of certain bones. The patella, two in the tendons of the flexor brevis pollicis pedis et manus, others in the other toes, rarely in the other fingers; those of the peroneus longus, tibialis anticus, and T. posticus; outer head of gastrocnemius, psoas and iliacus, biceps cubiti, gluteus maximus, tendons about ankle joint, &c. are examples of these.

In *Rheumatoid Arthritis* (a disease very common in, though not confined to, advanced life), the bones may be heavier, because they consist of a dense porcellanous tissue. Old bones are yellower, and more brittle than younger ones. The Haversian systems are less perfectly formed. Dr. Taylor cautions us (*loc. cit.* p. 149), against being too dogmatic as to the age of a skeleton. He says that in 1851, portions of a mutilated body were found in Norwich, and the medical evidence was that the bones, &c., belonged to a young adult female between sixteen and twenty-six years of age. Eighteen years after a man named Sheward confessed that these remains were those of his wife whom he had murdered (Norwich Lent Assizes, 1869, *Reg.* v. *Sheward*). It appeared, however, that the woman was in her fifty-fourth year. *Moral.*—Be satisfied with stating what you *know*—as in this case, that the woman was an adult, and do not guess at what you do *not* know, viz., the exact age.

Medico-legal aspects of Age. Minority and Majority.

In law any one *under twenty-one years of age* is an *infant* or *minor.* Before that age he cannot alienate his lands, goods, or chattels by deed or will. He cannot be called upon to serve on a jury before this age. At fourteen years, however, a male is considered to have arrived at years of discretion. By the "Royal Marriage Act," passed in the reign of King George III., the descendants of King George II. were prohibited from marriage before the age of twenty-five, without the consent of the king in council. Eighteen years of age is, however, fixed as the majority of princes and princesses for other purposes. This gave rise to many jocular remarks at the time. The age of twenty-one is generally adopted in Europe for majority, though in particular countries and at special times other ages (eighteen and twenty-five) have been and are customary. The law has fixed no age for *competency as a witness.* Hence in trials for rape or murder, the evidence of very young children is often, and we think properly, taken. The custom of the courts is to ascertain that such witnesses know the nature of a lie, and the importance of truth; and are acquainted with the rudiments of natural and revealed religion. Nearly all the judges (notably Justices Earle and Keating) have held that up to the age of *seven* years, the law presumes that a child cannot distinguish right from wrong, so as to be capable of crime; and evidence is inadmissible to show that such a child possesses this capacity. In *Whitly* v. *Hodgson* (May 1863, before Mr. Justice Keating), a boy under six years of age was held to be *doli incapax*, incapable of crime.

In July, 1784, William Horton, aged eleven years, was indicted for feloniously stealing sundry articles. In the charge to the jury the judges said, "The law fixes no particular time for the age of discretion as to the criminality of the party; and under particular circumstances courts have gone very far in adjudging children of very tender years to be capable of committing capital offences, even so young as the age of eight years (John Hudson, "going nine," tried in December, 1783, was found guilty of felony, for stealing property of the value of 22*s.*, and transported for seven years). In all cases, the question is, whether the jury are satisfied that the child, of whatever age, has sufficient knowledge and discretion to understand that he is doing a criminal act, for if he has, he is answerable to the law for the consequences; and whatever the feelings of courts and juries may be on such occasions, it would be highly detrimental to the public if any age was exempt, because people of full years would employ children to commit crimes of almost every description." ("Select Criminal Trials." 1803, vol. i.) This boy, whose age was between seven and fourteen, was acquitted. If "*a malicious* intent" can be proved, in other words, a guilty knowledge of the nature of the act, the law supposes that *malitia supplet ætatem.* A child under fourteen indicted for murder or arson, must therefore be shown to be conscious of the nature of the act. In the case of *Reg. v. Vamplew* (Lincoln Summer Assizes, 1862), Dr. Taylor gave evidence, and a girl under fourteen years of age was convicted of poisoning by strychnia. It is to be feared that children were sometimes hanged in the good old times for acts of which they only partially comprehended the meaning. Under fourteen a male infant is not supposed to be capable of rape, or even of a criminal assault in the first degree, but he may be convicted as a principal in the second degree. The patient, if above fourteen, may be convicted of unnatural crimes, although the agent be under fourteen. Under ten years of age, a female is presumed to be incapable of consenting to sexual intercourse (Taylor, *loc. cit.*, and "Taylor on Evidence," vol. i.). Full age is reckoned on the first instant of *the day before* the twenty-first anniversary of his birthday, although forty-seven hours fifty-nine minutes short of the complete number of days, counting by hours. This mode of reckoning is applicable to all ages. Some curious cases are given by Dr. Taylor bearing on this point.

N.B. When you attend a labour, always note carefully the exact minute at which the child is born, as this rule regulates the succession to estates. Note it at the time! By 1 Vic., c. 26, no will is valid if the maker be under the age of twenty-one years. A male at fourteen can consent or refuse to marry. A female may be betrothed, or given in marriage, at seven! at nine (Henry III., c. 20) she is entitled to dower; at twelve is at years of maturity! so as to consent or not to the marriage contract. But the law requires the consent also of the nearest of kin. As regards *crime,* the same rule is followed as with males. At twenty-one years of age, both male and female can contract marriages, and fulfil all legal and civil rights and duties, without consent of either parents or guardians (although certain *trusts* may limit powers). But marriages contracted by minors have been held valid, even against the parents' or guardians' consent. Age, in nearly all the cases we have named, must be proved whenever possible, by documents, not by medical evidence.

HEIGHT IN RELATION TO PERSONAL IDENTITY.

Stature of Skeletons.

The average height for males in England, brought up under favourable circumstances, is said to be 5 feet 9$\frac{3}{5}$ inches, for females 5 feet 2 inches. According to Dr. Sieveking, the weight should be in the following proportion:—

Model Heights and Weights.

The Height being	the Weight should be
5 feet 1 inch.	8 stone 4 lbs.
5 ,, 2 ,,	9 ,, 0 ,,
5 ,, 3 ,,	9 ,, 7 ,,
5 ,, 4 ,,	9 ,, 13 ,,
5 ,, 5 ,,	10 ,, 2 ,,
5 ,, 6 ,,	10 ,, 5 ,,
5 ,, 7 ,,	10 ,, 8 ,,
5 ,, 8 ,,	11 ,, 1 ,,
5 ,, 9 ,,	11 ,, 8 ,,
5 ,, 10 ,,	12 ,, 1 ,,
5 ,, 11 ,,	12 ,, 6 ,,
6 ,, 0 ,,	12 ,, 10 ,,

It is a familiar fact that we are all a trifle taller in the morning than in the evening. These statistics, and those at page 623, under the heading of the Normal Man, help us, however, but little in the determination of personal identity. The practical question usually is, given the length of one or two bones, or of the limbs, to determine the height of the entire skeleton or body. One or two general laws of proportion are more curious than actually useful. One of these is, that the height of the body is about the same length as from the tip of the second finger of one hand to the tip of the second finger of the other hand, when both arms are extended horizontally, to their utmost. In other words, if a line be drawn parallel with the base, or ground line, but passing across the summit of the head, and perpendiculars are let fall touching the tips of the fingers when the arms are extended to their utmost horizontally, the figure described is as nearly as possible a square. If the legs be then extended so as to form an equilateral triangle with the base line and the arms raised till the tips of the fingers are in a line with the top of the head, and in this position a circle be drawn from the umbilicus as a centre, the whole body will be included within this circle (Ward's "Osteology.").

Quetelet has noticed that the height of the ear is just half the distance from its opening to the top of the head; that the eye is to the mouth in the proportion of two to three; and that the length of the eye is measured five times in the temporal diameter of the head, and seven times in its antero-posterior diameter. The common rules:—"Thrice round your thumb's once round your wrist; thrice round the wrist's twice round the neck; thrice round the neck's once round the waist, &c.," are not far from the truth. Other curious proportions will be found in R. D. Hay, "On the Proportions of the Human Figure." The proportions of the nose being one-third of the face, and the head one-eighth of the total height, are now pretty generally adopted by artists, and will be found in the best Greek and modern statues. Of late, Millais and some other painters have given us figures, especially of females, whose lengths are out of all proportion to the rest of their bodies. Amidst the mass of materials from which to select the following seem to us deserving of tabulation. The first table is from M. Sue, in the "Mémoires de l'Académie Royale des Sciences," 1755, tom. ii., p. 574.

Age.	Total length.	Trunk.	Upper Extremities.	Lower Extremities.
Fœtus of 6 weeks	16 lines	1 inch	5 lines	4 lines
2½ months .	2 inches 3 lines	1 inch 8 lines	9 ,,	7 ,,
3 ,, .	3 in.	2in. 1 lin.	13 ,,	11 ,,
4 ,, .	4 in. 4½ lin.	2 in. 11 lin.	1 in. 9 lin.	1 in. 5½ lin.
5 ,, .	6½ in.	4 in. 4 lin.	2 in. 6 lin.	2 in. 2 lin.
6 ,, .	9 in.	5 in. [illegible] lin.	3 in. 7 lin.	3 in. 4 lin.
7 ,, .	1 foot, some lines	6 in. 5½ lin.	5 in. 10 lin.	5 in. 9 lin.
8 ,, .	14 in. 9 lin.	8 in. 3½ lin.	6 in. 8 lin.	6 in. 6 lin.
9 ,, .	18 in.	10 in.	8 in.	8 in.
1 year .	22½ in.	13 in. 6 lin.	9 in.	9 in.
3 years .	2 ft. 9 in. some lines.	19 in.	14 in.	14 in. some lines.
10 ,, .	3 ft. 8½ in.	2 ft.	19 in.	20 in. 6 lin.
14 ,, .	4 ft. 7 in.	2 ft. 4 in.	24 in. 6 lin.	27 in.
25 ,, . .	[illegible] ft. 4 in.	2 ft. 8 in.	30 in.	32 in.

At page 155 of Dr. Taylor's work, another table is given from M. Sue, in which the measurements are apparently somewhat greater; 24 to 27 inches for one year, 3 feet for 3 years, 4 feet for 10 to 12 years, 4 to 5 feet for 14 to 16 years, and 5 feet to 5½ feet for 20 to 25 years. The discrepancy, however, appears greater than it really is, the measurements in the first table being in old Paris feet, inches, and lines, of which 12 lines make 1 pouce or inch, = 1·066 English inch, and 12 pouces 1 pied de roi, = 12·79 English inch, or roughly 12¾ inches.

Measurement of Skeletons (in inches).—Dr. Humphry, "Human Skeleton."

	Height.	Middle point of.	Length of Spine.	Circumference of Skull.	Humerus.	Radius.	Hand.	Femur.	Tibia.	Foot.	Pelvis.	
											Transverse Diameter of.	Antero-posterior.
European (average of 25) .	65	Symphysis Pubis.	22·2	20·5	12·7	9·2	7·3	17·88	14·4	10·6	5·2	4·3
Negro (average of 25) . .	62	1 inch below Symphysis	19·3	19·8	12·1	9·4	7·7	17·	14·4	11·11	4·6	4·1
Bosjesman (average of 3)	54	Symphysis	17·	19·6	10·8	8·3	6·	15·	12·9	7·5	4·4	3·5
Idiot (in Berlin Museum) .	57		19·5	13·5	12·	8·8	7·	16·	12·5	8·5	5·	3·8

The same, reduced to a scale of 100.

	Height.	Length of Spine.	Circumference of Skull.	Humerus.	Radius.	Hand.	Femur.	Tibia.	Foot.	Pelvis.	
										Transverse Diameter of.	Antero-posterior.
European . .	100.00	34·15	31·54	19·54	14·15	11·23	27·51	22·15	16·03	8·	6·61
Negro . .	100 00	31·13	31·94	19·52	15·16	12·42	27·40	23·23	17·90	7·42	6·61
Bosjesman .	100·00	31·48	36·29	20·	15·37	11·11	27·78	23·89	13·78	8·15	6·48
Idiot . . .	100·00	34·21	23·68	21·05	15·43	12·28	28·07	21·92	14·96	8·94	6·66
O'Byrne at 8 ft. 2 inches . .	100·00	30·61	23·98	17·35	13·26	10·41	24·69	21·43	12·75	6 94	6·33
Irish Giant 8 ft. 6 inches . .	100·00	33·04	33·83	16·86	13·23	10·1	24·70	20·90	11·57	8·33	4·45
Sicilian female at 10 years, 20 inches . .	100·00	31·	70·	17·50	13·	11·	25·	17·50	14·	7·	7·[illegible]
Bébé at 23 (or N. Perry) 3 feet .	100·00			22·23	13·6		26·39	19·45		8·6	6·67

The next two tables are also taken from Dr. Humphry.

Measurements at different Ages (in inches).—Dr. Humphry.

Age.	Height.	Spine.	Circumference of Skull.	Humerus.	Radius.	Hand.	Femur.	Tibia.	Foot.	Pelvis.	
										Transverse Diameter of.	Antero-posterior.
At Birth	19	7·	15·	3·5	2·5	3·1	4·3	3·5	3·5	1·3	1·3
2 yrs.' average .	27	8·5	17·7	4·7	3·6	3·1	6·2	5·1	3·6	2·2	2·2
4 to 6 average ..	35	11·8	18·	6·6	4·8	4·1	9·1	7·1	5·1	2·5	2·5
8 to 12 average	43	12·8	18·8	8·[illegible]	6·	5·1	11·4	9·4	6 4	3·1	3·1
15 yrs. Female	55	17·	19·	10·3	7·	5·8	14·8	11·	7·8	4·	3·6
15 yrs. Male	54	16·5	19·	10·5	7·5	5·6	15·0	11·5			
15 yrs. Average.. ..	54	16·6	19·3	10·4	7·4	5·7	14·8	11·6	8·	3·8	3·3
18 to 19 yrs. Female ..	59	19·	19·5	11·	8·2	6·5	16·	12·8	8·	5·	4·8
18 to 19 yrs. Male	59	17·5	20·4	11·	8·5	6·3	15·	13·	8·	3·9	3·8
18 to 19 yrs. Average .	60	18·5	19·8	11·4	8·6	6·6	15·8	13·3	8·3	4·7	4·5

Average Measurement at different Ages, reduced to a Scale of 100.

Age.	Height.	Spine.	Circumference of Skull.	Humerus.	Radius.	Hand.	Femur.	Tibia.	Foot.	Pelvis.	
										Transverse Diameter of.	Antero-posterior.
Birth	100·00	37·0	79·	18·5	13·2	16·3	22·6	18·5	18·5	6·8	6·8
2	100 00	31·48	65·55	17·40	13·33	11·48	22·94	18·88	13·33	8·14	8·14
4 to 6	100·00	33·71	51·42	18·85	13·71	11·71	26·00	20·28	14·57	7·14	7·14
8 to 12	100·00	29·76	43·72	19·30	14·09	11·86	26·51	21·86	14·65	7·21	7·21
15..............	100·00	30·74	35·70	19·25	13·70	10·55	27·40	21·48	14·81	7·03	6·66
18 to 19	100·00	30·83	33·00	19·00	14·33	11·11	26·33	22·16	13·83	7·83	7·50
Adult	100·00	34·15	31·54	19·54	14·15	11·23	27·51	22·15	16·03	8·	6·61

Orfila's measurements show remarkable differences. Dr. Guy (*loc. cit.*, p. 11—13) has criticized them somewhat severely. They are however often quoted, and we reproduce them, to shew that it will not do to be too dogmatic on such points. The measurements are given in inches, and fractions of an inch.

Orfila's first Table.

Stature of the skeleton calculated from the cylindrical bones :—

Length of Bone.		Stature.		
	Inches.	Max.	Min.	Diff.
Humerus (19 obs.)	14·5	68·1	64·5	3·6
Ulna 14 ,,	10·66	70·8	65·66	5·14
Femur 12 ,,	17·75	69·66	64·5	5·16
Tibia 11 ,,	14·21	69·66	64·5	5·16

Orfila's second Table.

Length of Bone.		Stature.		
	Inches.	Max.	Min.	Diff.
Humerus (6 obs.)	13·	73·25	69·75	3·50
Ulna 7 ,,	10·66	73·25	65·	8·25
Femur 7 ,,	18·1	72·	67·	5·
Tibia 7 ,,	15·	70·5	65·	5·5

Dr. Guy gives the following table of averages from the measurement of forty-four male and seven female subjects. (In inches and parts of inches) :—

Sex.	Stature.	Vertex to Pubes.	Pubes to Foot.	Upper Extremity from Acromion.	Femur.	Tibia.	Fibula.	Humerus.	Radius.	Ulna.
Male ..	66·5	33·5	33·	29·5	17·66	14·58	14·16	12·4	9·4	10·16
Female	61·	31·1	29·9	26·66	16·5	13·75	13·4	11·6	8·66	9·75

Dr. Taylor gives the following measurements of three adult male skeletons, two being average heights, and one, No. 3, above the average ; and two females—one an adult, the other an old woman :—

No. of Skeleton.	Stature.	Transverse from tips of Middle Fingers.	Femur.	Tibia from Articular Surface.	Fibula from ditto.	Humerus.	Radius.	Ulna.	Clavicle.	Hand from Carpus joining the Radius.
No. 1 M.	66·	66·5	17·4	15·4	13·5	12·	9·	10·	5·9	7·
,, 2 M.	69·	60·5	18·	14·75	14·	12·	9·25	10·4	6·	7·25
,, 3 M.	72·	61·	19·5	15·5	14·5	13·25	9·4	10·4	6·	6·50
No. 4 F.	62·5	62·5	16·	12·75	12·5	11·12	8·	9·	5·5	6·50
,, 5 F.	60·	60·75	16·	12·5	12·25	11·25	7·9	8·75	5·	6·25

He also gives the following as the measurements of bones of the arm of a well-formed soldier whose stature was *about* six feet.

Total length of arm 29·5 inches
29·5 × 2 = 59· ,,
Clavicles = 12· ,,
Sternum (*width*) 1½· ,,

Humerus, 12½ inches ; radius, 9¼ inches ; ulna, 10¼ inches; clavicle, 6 inches ; hand from wrist, 7⅜ inches ; and the following measurements of detached bones used for demonstration : (Male) Femur, 18 inches ; tibia, 15¾ inches ; fibula, 15 inches ; humerus, 12¾ inches ; ulna, 10¼ inches ; radius, 9¼ inches. We quote from the same authority the following :—

	Male Skeleton between 10 and 12 years of Age.	Mature Child at 9 Months Utero-gestation.
Stature	46 inches.	$19\frac{3}{4}$ inches.
Femur	$11\frac{3}{4}$ "	3 "
Tibia	$9\frac{3}{4}$ "	$2\frac{5}{8}$ "
Fibula	$9\frac{1}{2}$ "	$2\frac{1}{2}$ "
Humerus	$8\frac{1}{2}$ "	$2\frac{1}{4}$ "
Radius	6 "	2 "
Ulna	$6\frac{3}{4}$ "	$2\frac{1}{4}$ "
Clavicle	4 "	$1\frac{5}{8}$ "
Hand from Wrist	5 "	2 "
Arms (each)		$8\frac{1}{4}$ "
Measurement across the Chest		$3\frac{1}{4}$ "

The subjoined table of measurements is taken from Barthes and Rilliet's well-known book on the diseases of infants. It is founded on measurements of thirty-seven well-nourished and well-grown children:—

	$3\frac{1}{2}$ to 5 Years.	6 to 10 Years.	11 to 15 Years.
	Inches.	Inches.	Inches.
Height	32·8 to 38	38 to 50·8	50 to 52·8
Length of Sternum	4·4 to 5·2	4·8 to 6	5 to 7·2
Length of *Dorsal Vertebræ*	5·6 to 8·8	7·2 to 10·4	9·2 to 11·6
Space between the Coracoid processes	5·2 to 6·8	6 to 8	7·6 to 10·8
Round Thorax under Armpits during inspiration whilst seated	20 4 to 24·4	22·4 to 26·8	27·6 to 35·2
Round Thorax under Nipples during inspiration	22 to 25	22·4 to 26·8	27·2 to 32

Although referring to the living, some of the details are applicable to dead bodies and to skeletons.

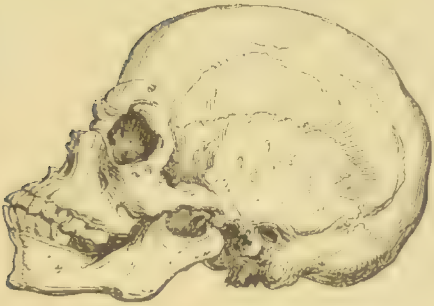
In calculating the stature from a skeleton, it is usual to add from $\frac{1}{2}$ an inch to $1\frac{1}{2}$ inch for the soft parts. Some additional *proportions* are given by M. de S. Luca ("Cosmos," Oct. 2, 1863, p. 386), which we take from Dr. Taylor (*loc. cit.*, p. 156). He takes the average male height for the adult to be 63 inches, or 160 centimetres; of an adult woman, $\frac{1}{20}$th less, or about 5 feet. Of this the head = $\frac{1}{8}$th, divided into two equal parts immediately below the eyes, the nostrils being midway between eyes and chin. In a vertical section of the body the pubis is a central point between the two extremities. When the arms are raised vertically above the head, the navel, which is 1 metre (39·37 inches) from the sole of the foot, then becomes the centre of the length. He divides the arm into five parts, of which the hand is one, the forearm and arm being two each. Multiplying the length of the hand by five we get the length of the arm (say 5·22 by 5 = 26·10). The carpal and metacarpal bones represent half of the length of the hand. The first phalanx of the middle finger = $\frac{1}{4}$th of hand; its last two phalanges are together exactly the length of the first. The last phalanx is just halved by the nail. The sole of the foot is one-third longer than the palm of the hand, but the back of the foot, or instep, is of the same length.

The centre of gravity of the human body (according to Weber) in the anderect horizontal positions, is only a fraction of an inch above the promontory of the sacrum, so that in fact it traverses the lumbo-sacral articulation.*

Identity from Race.

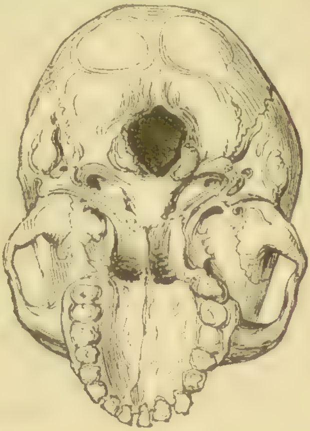
The chief differences in the skeletons of men of different races will be found in the skull. The figures in the text (taken from Dr. Carpenter), show the skull (profile and base) of a negro; in the profile the *prognathous* jaws are clearly seen; the *pyramidal* skull of an Esquimaux (front and basal views), and the oval skull of a *European* (Indo-European or *Caucasian*). In *Mongolians* the malar bones are very prominent. In the negro, besides the characters of the skull, the feet are very wide and flat, and the os calcis remarkable for its backward projection. For the

FIG. 63.



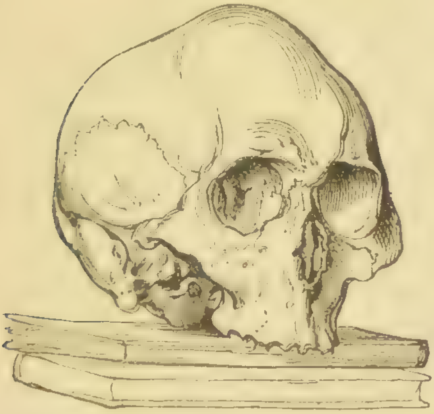
Skull of Negro—Profile.

FIG. 64.



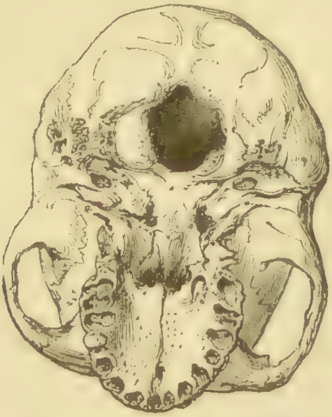
Skull of Negro—Base.

FIG. 65.



Pyramidal Skull of Esquimaux—
Front View.

FIG. 66.



Esquimaux—Base of Skull.

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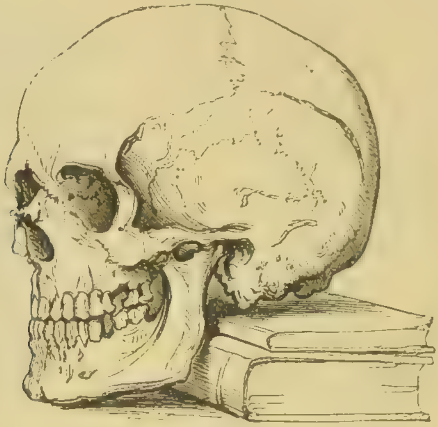
* Dr. Taylor states the weight of a perfect male skeleton at 10 lb. 6 oz., and that of a female at 8 lb. 13 oz.; both were completely dry. He gives the specific gravity of human bone at 2·01 as compared with water.

general characters of the different races of mankind, we must refer—(1) for a brief account, to Dr. Carpenter's "Principles of Human Physiology," ch. xix., p. 925 of 7th edition, and to the article Ethnology, and the plates in "The Popular Cyclopædia;" (2) to Dr. Prichard's "Physical History of Mankind," 5 vols., 1849, and "Natural History of Man," (1843); (3) and to the transactions of the Ethnological and Geographical Societies.

FIG. 67.



European—Oval Skull.

Cloquet, Cruveilhier, and some other anatomists have stated that the capacity of the skull is about the same in different races. Tiedemann, Ward, and later writers have (after experiment) come to very different conclusions. Thus Ward gives the following table (*loc. cit.* p. 61.)

		Weight of Skull without Lower Jaw.	Weight of Millet Seeds contained.
French	1.	26·0 oz. avoir.	42·5 oz. avoir.
	2.	20·6 „ „	31·5 „ „
Chinese	1.	34·5 „ „	37·25 „ „
	2.	27·0 „ „	39·25 „ „
Scythian	1.	40·25 „ „	34·0 „ „
	2.	32·0 „ „	35·75 „ „

In the museum of the London Hospital, there are skulls of different races, which might easily, both for size and capacity, be taken to be European, though not so. Hence extreme caution must guide you in drawing conclusions as to race from bones only. The skin of the negro and that of other dark races is peculiar in the great depth of colour and thickness of the rete mucosum, or stratum Malpighii. The hair is also well known to be modified by race.

III. *Personal Identity from Personal Peculiarities, Scars, Marks of Fracture and Dislocation, Loss of Limbs, &c.*

This part of our subject may be divided into two parts—(1) Personal peculiarities which are congenital; (2) Those which are acquired. In regard to the former, the facts of hereditary transmission of peculiar features are too well known to need more than simple mention here. We may remind you of the remarkable *likeness* of successive generations in our own and the Austrian royal families. Not only the features, but tricks of manner, modes of speech, handwriting, left-handedness, and the like, are handed down from father to son, though occasionally they skip a generation (atavism). A remarkable instance of this is known to the authors: A man who shot with the left hand, never saw his son; and the son grew up in entire ignorance of his father and of his father's method of shooting. He also was a left-handed shot, both being excellent marksmen.

Moles, and nævi, and polydactylism [*see* 2 Sam. xxi., 20; and 1 Chron. xx., 6], are also transmitted through many generations. So are such peculiarities as hypospadias (*see* chapter on Monstrosities). Gout, consumption, and syphilis are familiar examples of hereditary diseases. Of the latter we may say, in the language of Byron,

> "See what thy guilty love has done,
> Repaid thee with too like a son."

Readers of Horace do not need to be reminded that this poet has sketched the main facts of heredity in the fourth ode of his fourth book,—

> "Fortes creantur fortibus et bonis:
> Est in juvencis, est in equis patrum
> Virtus: nec imbellem feroces,
> Progenerant aquilæ columbam."

It has generally been held that the *male* parent transmits the characters of the skeleton, the conformation of the limbs, of the brain, and of the senses—in other words, the animal characters, or organs of sensori-motor life; whilst the *female* parent is supposed to transmit the constitution, and the internal organs, particularly the chylo-poietic viscera; or the organs of vegetative life, and the sympathetic nervous system. This may be mainly true, but the exceptions are so numerous, that the rule is useless in a medico-legal point of view. That the parent whose age is in excess, will, *cæteris paribus*, determine the sex, is now generally admitted by breeders of sheep and cattle. One caution is, however, necessary. *Likeness or resemblance, however strong, does not necessarily prove paternity, taken by itself, partly on account of atavism, and partly because it is extremely probable that strong impressions made upon the mother's mind may determine resemblances*, as in the well-known case of Jacob's rods and speckled sheep and goats, Gen. xxx. 32, *ad fin.*

Moles, particularly hairy ones, are sometimes transmitted through several generations. *Nævi*, or mother's marks, are far more common than is generally supposed. Even when these have been removed by surgical operation, a permanent cicatrix will be left, except perhaps in the case of very small or capillary nævi. *One eye* (iris) *is sometimes of a different hue to the other.* This is rare in the human subject, though pretty common in cats and some other animals. Such evident malformations as hare-lip, or cleft-palate will scarcely escape attention; though, especially after the growth of a moustache, the traces of these deformities, after surgical skill has intervened, are often very slight indeed. A double or bifid uvula is a somewhat rare malformation (less than 1 in 10,000).

It has often happened that the *loss of one or two fingers*, or of a whole limb, has led to the identification of a criminal or of a body. The *presence or absence of teeth*, and especially of *artificial teeth*, has several times been a turning point in questions of personal identity. One such case, quoted by Dr. Taylor, is excessively curious. Briefly, this case is as follows: *Elizabeth Ross* was tried at the Old Bailey in December, 1831, for the murder of *Caroline Walsh.* The murdered woman, a native of Ireland, was traced to the prisoner's room. Ross's son deposed to his mother's suffocating the old woman Walsh, and then going out with something heavy in a sack. [The high price and scarcity of anatomical subjects at that time, rendered such murders profitable.] The evening of the day following, an old woman called Caroline Welsh, also an Irishwoman, was found in a neighbouring street in an exhausted and dirty condition, with a fractured hip, and taken to the London Hospital, where she afterwards died, and was buried. Ross, the prisoner, asserted that this was the woman she was accused of murdering. Notwithstanding the son's evidence, the defence was a plausible one, but after examination of about twenty witnesses, it was proved, that though both were Irish, yet *Walsh* came from Kilkenny, *Welsh* from Waterford. *Walsh,* who was murdered, was eighty-four, tall, sallow, had grey hair, and, strange to say, *perfect incisor teeth. Welsh*, who died in the London Hospital, was about sixty, tall, dark as a mulatto, and had no front teeth. One medical witness swore that the *alveolar cavities had been obliterated for a considerable time.* The jaw was brought into court, but not produced. Lastly, two daughters of Walsh swore that the body of Welsh was not that of their mother. Some other resemblances (of dress and of baskets) were proved. But Walsh was healthy, clean, and neat, and in fair condition. Welsh was dirty, and much emaciated.

On the trial of *Professor Webster* for the murder of Dr. Parkman, at Boston, U.S., in 1850, the evidence of the dentist, Dr. Keep, who supplied him with sets of artificial teeth, in blocks for each jaw, four years before, was of great importance. Although an attempt had been made to destroy them by fire, yet enough remained to identify them. The very heat used to melt the gold had given a pink colour to some of the teeth, thus proving the use of gold. One of the blocks fitted to a great natural irregularity in the lower jaw of the murdered man.

In the *Tichborne* trial, very much depended upon the following facts:—

1st. The lobes or lobules of the real Roger's ears were very badly developed, and continuous with the face. The Claimant had well marked lobes to his ears. 2nd. The real Roger had an issue in one arm, kept open a long time, which was almost certain to have left an indelible mark or scar. Some said he had a seton also. 3rd. The real Roger had been bled frequently in both arms, both ankles, and one temple. 4th. There was considerable evidence to show that he had also been tattoo'd. 5th. The Claimant asserted, or a witness called Brown for him, that he had a brown mark on his side. It did not appear, however, that the real Roger ever had a similar mark. In regard to the operations mentioned, note that in the vast majority of cases the *marks of venæsection are very permanent and evident.* The authors have seen marks of bleedings performed twenty-six, thirty, and even fifty years ago, and cupping marks of equal antiquity. The scar of the lancet (if bleeding have been done properly) is oblique. It is usually at the bend of the elbow. Yet the authors have known cases of similar marks (in young persons) disappearing in less than twelve years. Remember that *all cicatrices, no matter what their original shape, get modified by time, and the vast majority of them become more and more linear.* In relation to tattooing, the authors have examined some hundreds of tattoo marks on persons of differing ages, sex, and nationality, and the result of their examination is, that in an overwhelming proportion of cases, these marks are practically indelible, except by such means as destroy the skin also, "they fade, but do not disappear," if the operation has been efficiently performed. This permanence is particularly the character of marks made by needles, and rubbing in of lamp-black, indian-ink, gunpowder, charcoal, or any mainly carbonaceous material. On the other hand, indigo, vermilion, and Prussian blue do sometimes, in the lapse of years, become obliterated. Cobalt and ultramarine blues have, in our experience, proved very permanent. Orfila, Tardieu, and Taylor substantially agree in this view of the question. The scars of burns and scalds, as well as of branding—as in the army, deserters used to have a D. thus imprinted, and French convicts the letters T. F. (travaux forcés),—are also extremely permanent. When such marks have become faint, slightly rubbing the skin, or striking a smart blow with the flat hand, sometimes makes the mark evident; on the principle that cicatrices are poorly supplied with vessels; hence the healthy skin reddens, leaving the cicatricial tissue conspicuous by its whiteness.*

The following diseases and accidents leave more or less permanent marks: apoplexy [if hæmorrhagic]; aneurisms; amputation of fingers, toes, limbs, breast, &c. [is it necessary to remark that in the human subject lost parts are not reproduced, as in some of the lower animals?]—abscesses; boils, carbuncles, buboes [whether from plague or other fevers, or from gonorrhœa]; operations for the removal of tumours, if of any size, ditto for caries and necrosis; circumcision and castration; still more ovariotomy; cleft-palate, and hare-lip; operations for hernia, for artificial anus [Amussat's, Littré's, &c.]; anchylosis; bleeding in all its forms, such as arteriotomy [temples], venæsection [bend of elbow, backs of hands or feet, neck, &c.]; cupping [leaves rows of short parallel lines]; leeching [leaves triangular marks]; burns; and scalds—the latter, if severe, can scarcely be distinguished from burns;—fly-blisters, mustard, and other vesicants leave scars or brown marks in many cases; the actual cautery and caustic closely resemble burns; cancer and other tumours; cataract and some other diseases and operations of and about the eye, as entropion, symblepharon, excision of eyeball, &c.; cirrhosis [of liver, spleen, kidneys, &c.], diphtheria; dislocations, if unreduced, or complicated with fracture, or with much injury to soft parts; diseases of joints, and accidents to ditto; excision of joints; erysipelas, if very severe; emphysema of lungs, eczema rarely; fractures almost always, however well set, especially if ununited [the identity of Dr. Livingstone's body was proved by an ununited fracture of the humerus, due to the bite of a lion]; gangrene; gout, rheumatism, arthritis deformans [chalk stones, tophi in ears, crippled and deformed joints, &c.], and other "rheumatic" affections of joints; gôitre [see Cretinism under

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* Foderé says a cold pewter plate reveals such scars and those of floggings, &c.

Insanity]; glands, strumous or scrophulous and other diseases of; gunshot and other wounds; gunpowder and other explosions; [fireworks, dynamite, guncotton, &c., &c.]; hernia, herpes zoster; hydrocephalus; heart-disease, valvular degeneration; issues and setons; jaundice; ligature of arteries, and operations for varicose veins; lupus, rodent ulcer; moles; molluscum fibrosum and contagiosum; malignant pustule; nævi, and other "mother's marks;" nodes and periostitis; opening the abdominal cavity, as in gastrotomy, gastrostomy, and the Cæsarian section, removal of large uterine fibroids, ovarian tumours, &c.; scurvy and purpura; spina-bifida; phthisis; pleurisy; pneumonia; pyæmia and septicæmia; trephining, tracheotomy, [also laryngotomy or bronchotomy; and for similar reasons œsophagotomy, and pharyngotomy]; tubercular disease; tenotomy [sometimes—rarely if subcutaneous]; variola (small-pox); varioloid, and vaccination; ulcers, external and internal—many of these ulcers are due to tubercular, syphilitic, or cancerous disease.

This list is not put forward as exhaustive. Most acute imflammations, such as hepatitis, gastritis, &c., will exhibit signs familiar to the pathologist, if the patient dies in the attack; but if he recover, and die at a subsequent period, no certain sign of the previous disease may be found. As regards *typhus fever*, the rash resembling the petechiæ of purpura might be found after death within the first fourteen days, along with a dark fluid state of the blood, which is said to be deficient in fibrine; and general congestion of all the internal organs. In *typhoid or enteric fever* (dothinenteritis) Peyer's patches in the lower end of the ileum should be examined; no rash on the skin will be found after death. After measles and scarlet fever, particularly the latter, the skin may be found desquamating, and the urine will probably be albuminous. In most infective diseases, the spleen will be found enlarged. For the special signs in hanging, drowning, and, suffocation, we refer you to the special chapter on these subjects. [*See* Delafield's "Hand-Book of Post-Mortem Examinations;" Jones and Sieveking's "Manual of Pathology" (Churchill's); Rindfleisch's "Pathol. Anatomy" (Dr. Baxter's translation, New Sydenham Society); Wilks and Moxon's "Hand-Book of Pathology." The bibliography at the end of "Rindfleisch" gives a copious list of larger works and monographs, by such men as Andral, Billroth, Cruveilhier, Lebert, Morgagni, Rokitansky, Virchow, &c., &c.] The effects of time, disease, trouble, trades, and artistic skill on the colour of the hair have already been noted. (*See* page 576.)

IV. *Habits and gestures* have occasionally led to the arrest of criminals, and the recognition of relatives. In our opinion, it would be unwise to lay too great stress upon these, except in conjunction with other unmistakable marks of identity. How easy it is to make mistakes is shown by the case of Martin Guerre, brought before the parliament of Toulouse, in 1560 ("Foderé," vol. i., chap. 2, from the Causes Célèbres, par Mejan). Martin Guerre had been away from home eight years. An adventurer, called Armand Dutille, who appears to have exhibited the closest possible resemblance in features and person to Guerre, passed himself off as the man himself; was accepted as her husband by Guerre's wife, who had children by him, and took possession of all his property. He lived three years in the family, with four sisters and two brothers-in-law of Guerre's, without exciting their suspicions. At last, his claims were disputed, but when the matter came to trial, only the re-appearance of the real Martin Guerre, and the full recognition of the true man by the brothers and sisters led the judges to pronounce Dutille an impostor. Foderé's book mentions several other curious cases, most of which are quoted by Beck (*loc. cit.*, p. 372, &c.). One more, that of *Baronet*, is worth quoting. He was born in 1717, in the diocese of Rheims, and left his home at twenty-five to get his living as a domestic, and he returned home after twenty-two years to claim a little property. His sister had spent this, and persuaded a neighbour, named Babillot, to claim her brother as his son. He did so at first, but recanted. However, as his sister denied him, Baronet was sent to the galleys. After a few years, public opinion changed, and the parliament of Paris was appealed to. Amongst others, Louis, the great surgeon, was consulted. He inclined to *Baronet's* side, and the man was restored to liberty and his legal rights. Amongst other differences, *Baronet* was sixty, Babillot only forty-six; the latter had a *nævus on his thigh*, according to old Babillot the father, whilst *Baronet* had no such mark.

Dr. Guy (*loc. cit.*, p. 2) mentions the case of a barber's apprentice named Mall, who, in 1772, was tried at the Old Bailey for robbing a Mrs. Ryan. He was positively identified by the witnesses, and the whole court adjudged him guilty. But on referring to the books of the court, it was proved that on the day and hour when the robbery was committed he was on his trial at the bar, where he then stood for another robbery, in which he was also mistaken for the thief.

Such cases of mistaken identity are a fruitful theme for the novelist, and prove the common saying, that truth is more wonderful than fiction.*

The great *Tichborne* Trial almost entirely turned upon personal identity. The question was there raised as to whether a man would be likely to forget a language (French), which, if not actually his native language, was learned in very early life, and was more familiar to him than English. Holding as we do a strong opinion that the plaintiff was not Roger Tichborne, we yet think that both the Lord Chief Justice and the counsel for the prosecution made too much of the Claimant (or prisoner's) forgetting French, Latin, and other languages, and even of his loss of memory. One of the authors met Dr. Livingstone on his first return from Africa, after many years' absence, during five or six of which he had spoken only Dutch or African languages. He had almost entirely forgotten English (his native language). It is, too, a matter of common observation, that boys who have spent some years in learning Greek and Latin, will forget almost all of it after a few years in the Bush.

Loss of memory, both for words and things, is associated with many diseased conditions of brain, and may be produced by accidents. However, the *onus probandi* rests with the claimants in such cases, or with the prisoner who has to prove his innocence.

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* The following is taken from the "Dover Standard" of December 25th, 1875 :—

"MISTAKEN IDENTITY.—A curious story comes from Kensington :—On the morning of the 9th instant the body of a man, in a somewhat mangled condition, was discovered about a half mile distant from the Addison-road station, and two days later was identified by a woman named Triggs, of Cumberland-place, Hammersmith, as that of her husband. Further identification was forthcoming also in the testimony of one of Mrs. Triggs' children and of the supposed employer of the deceased man. An inquest was held at the Kensington Workhouse, and a certificate for burial granted by the coroner, Dr. Diplock. Within an hour of the interment, and as the hearse was nearing the door of Mrs. Triggs, to the surprise of all parties the latch was lifted, and William Triggs, the husband supposed to be dead, entered the house, and gave a satisfactory account of his absence for a week."

V. *Evidence from Handwriting.*

It is seldom that medical men, as such, are called upon to give evidence as to handwriting. Experts, such as Mr. Chabot, are generally summoned in such cases, or the cashiers of banks, or intimate friends or relations. Occasionally, however, the medical attendant of a testator who is deceased, or a scientific chemist, if forgery or erasure be suspected, is asked to give evidence in such cases. On this point the following principles may safely be laid down :—

1. The *style* of the handwriting depends partly upon the writing-master, and partly upon personal characteristics. Pupils of the same master, and members of the same family, often write similar hands. Very clear, clean, neat writing, with proper stops, crossed t's and dotted i's, show the careful, accurate, and methodical man ; whilst the blurred, blotted, erased, and almost illegible hand of another, shows opposite qualities. Hence the so-called science of graphiology ! But ludicrous mistakes as to character may easily be made if only autograph signatures, or small portions of letters be seen. Ill-health, intemperance, narcotics, tobacco-smoking in excess, scrivener's palsy (writer's cramp), other paralyses, a bad pen, bad ink, or bad paper, will all greatly alter the general style ; and hence the same person, at different ages, and even at different times of the same day, may write (his name, for instance) very differently at one time to what he does at another. Yet, allowing for all these differences of the individual from himself, it may safely be said that,—

2. Every person, male or female, gentle or simple, has a style of handwriting of his or her own ; and no two writings are quite alike, unless one is purposely imitated from the other, or traced from it. In order to learn what the style of the person whose writing we are studying really is, we should next,—

3. See as much of the writing as possible, and,—

4. Examine it with a lens as well as with the naked eye. Erasures, and different kinds of ink, and the effects of re-agents, can often be better seen in this way.

5. We should study—(*a*) how he makes his capitals, and (*b*) his small-letters—the latter, in the opinion of most experts, are the more important ; and (*c*) how he joins his letters, and if he joins words ; (*d*) the contractions he employs ; (*e*) his method of punctuation, and the way he begins and ends his letters ; (*f*) the way he makes his figures ; (*g*) particular methods of spelling, or mistakes (leaving out a letter, &c.), which frequently recur ; (*h*) the use of particular phrases, and the general style of composition, as for example, if the style be studiously correct, or free and colloquial, if classical or poetical quotations are introduced, and the like.

The following extracts from Mr. Chabot's evidence in a trial of a ship-owner for forgery and perjury in September, 1875, will explain our meaning :—

> "The letter *m*, in the word *management*, was commenced somewhat distinctively. Defendant frequently commenced his *m's* similarly, as appeared in several of his letters. . . . . There was no distinctiveness in Mr. D——'s *g*, but there was in the defendant's, in numerous instances which corresponded with the *g* in the disputed words. In the letter *r*, in another letter of Mr. D——'s, there was not a shoulder to it there was in the letter *r* of the disputed words ; and in the defendant's writing, there was frequently that shoulder to his *r*'s. . . . . Mr. D—— always began his letter *t* with a thick stroke, and the letter *t* in the disputed words and his letters were very much alike."

In a disputed will case, the will of a blind lady, the same witness spoke of "the singular way in which Cooper (one of the prisoners) wrote the word Queen.* There was no *Q*, but two *u's*, and this appeared in the alleged will. There were other peculiarities, such as a small *a* for Adolphus, which the deceased was never guilty of writing." Many words were mis-spelled. Photos of the writing were produced in court, and Mr. Chabot had to undergo a searching cross-examination. He had no reason to alter his opinion of the various modes of writing ; and specially pointed out the way in which the deceased, during the last month of her life, joined all her words together, for she was so blind that if she took up her pen, she knew she could not place it down again on the same spot. He could not say whether he could come to the conclusion that the will was a forgery, without reference to the small letters. Mr. Chabot was also a witness in the great Tichborne case.

It may be well to explain here that the medical term "agraphia" does not mean total inability to write, but is analogous to "aphasia," "aphemia," and similar terms, used to express loss of co-ordinating power, or loss of memory, for certain words and certain combinations of letters or words.

Writing Inks. Sympathetic Inks. Forged Documents, and Cryptography.

Since the time of Ovid, who taught lovers to use lemon-juice, and warm it ; milk to be rubbed over with soot ; and other methods of secret writing ; a great many sympathetic or invisible inks have been invented. Some of these are indicated on the table in the next page.

See Beckman's "History of Inventions" (Leipzig, 1780—1805 ; 5 vols.). A translation appears in 2 vols. in Bohn's series. Article "Sympathetic Inks." *See* also the various encyclopædias.

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* The prisoner wrote it so several times when asked to write the word "Queen."

Ink.	Developer.	Colour.
Solution of galls.	Dilute solutions of protosulphate of iron. (A little alum improves this.)	Dark brown or black.
Dilute solution of prussiate of potash (ferrocyanide of potassium).	As above, or dilute perchloride of iron solution.	Rich blue.
Cobalt (dissolved in aqua regia), and diluted = chloride of cobalt $Co''Cl_2$.	Held to the fire and heated, so as to be anhydrous. (A hot iron may be used.)	Blue. (Fades again as it cools in a moist atmosphere). Can be rendered visible again.
Mixed chlorides of cobalt and nickel.	Treated as above.	Green. Fades as the one above, and again appears with heat.
Dilute solutions of gold and silver salts (*e.g.* gold chloride $AuCl_3$, or silver nitrate, $AgNO_3$) in distilled water.	Exposed to light or heat, especially in organic matter.	Brownish black or purple tint. (Must be kept in dark till it is to be read.)

Nearly all the common black writing inks contain gallate or tannate of iron, held in suspension by gum. Galls contain gallo-tannic acid and pectose, or jelly, which converts the gallo-tannic acid into gallic, by exposure to air. This gives a deeper black with ferric salts, than gallo-tannic acid alone. It is considered best for part of the oxidation to take place on or in the paper. Hence the ink is bottled, and acids (sulphuric, commonly) are added to delay the oxidation. Cloves, carbolic acid, and other antiseptics, are added to prevent its becoming mouldy. The following table from Watts' "Dictionary of Chemistry" shows the composition of several inks :—

Ingredients.	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*
Galls	225·	187·	133·	125·	66·	62·	31·	50·	174·	50·	60·	42·	33·
Green Vitriol	75·	73·	55·	24·	22·	31·	19·	32·	87·	16·	20·	21·	11·
Gum	25·	73·	55·	24·	19·	31·	8·	9.	43·	47·	20·	16·	11·5
Logwood	..	..	..	..	..	..	..	..	..	100·	20·	21·	33·
Vinegar	..	..	..	..	..	..	..	125·	135·	..	..	..	.
Sugar	..	..	..	..	..	..	..	..	..	23·	1000·	16·	..

These ingredients are calculated for 1000 parts of water ; *a*, *b*, *c*, are rather too strong for common use ; *d*, *e*, *f*, are very good ; *g*, is rather too pale. *J*, *k*, *l*, are copying inks, containing as they do sugar, which causes the ink to adhere when dry, so that a copy may be taken off by pressing a moistened sheet of unsized paper upon the written paper.

The so-called Alizarin inks contain a little free acid, and generally some sulphate of indigo. Such inks become very black by exposure to ammoniacal fumes. Extract of logwood mixed with potassium chromate makes a good black ink, which does not mould ; it is, however, apt to get viscid and gelatinous. Nearly all the inks mentioned can be removed by chlorine, oxalic acid solution, or dilute hydrochloric acid. Indian inks added to them prevent this. Traill's indelible ink is prepared by dissolving wheat gluten in vinegar of sp. gr. 10·33, after steeping it 24 to 36 hours in water, and rubbing up the liquid with Indian ink or lamp-black. Another indelible ink is formed by mixing *decoction of galls with vanadate of ammonia.* Chlorine destroys the black, but does not remove the ink. Acids turn it blue. Some of the *silver* inks (permanent marking inks) are almost indelible, but cyanide of potassium dissolves them.

Aniline black and other aniline inks are now often used.

Blue Inks. Prussian blue 30 parts, oxalic acid 4 parts, water 1000 parts. Another contains: Prussian blue 12·5 parts, oxalic acid 25 parts, water 1000.

Red Inks. 1 part of good carmine dissolved in 120 of caustic ammonia, 1½ gum Arabic. A cheaper one = 12 parts of powdered cochineal, 4 parts ammonia carbonate, 32 parts of hot water. Digest and decant. Another by boiling 2lbs. Brazil wood, and 1½lb. Rupel or Roch alum, and 2 gals. of good vinegar. Boil to half.

Yellow and Green Inks. The former by decoction of saffron, the latter by indigo-carmine, mixed with picric acid.

Printers' Ink is essentially carbonaceous, containing boiled linseed oil (first clarified), yellow soap, drying ingredients, such as borate of manganese and lamp-black (16 per cent. of the oil, added and stirred up.)

Vermilion, ultramarine, and lead-chromate, are used for red, blue, and yellow inks, instead of the lamp-black.

Erasures can be detected in various ways—with a lens, or sometimes by merely holding up the paper to the light; sometimes by wetting it on a plate of glass, when the liquid will be found to be more greedily absorbed at the erasure than elsewhere. The use of paraffin, of turpentine, or of benzol, has also been recommended when the paper is very thick. The character of the original paper, whether hand or machine made, whether glazed on the surface only or all through, deserves careful study. Forgers often use some gum, varnish, or glaze, over the spot they have scraped or erased. Size and other animal gelatines are browned by weak iodine solutions. Starch will turn blue with the same. Gum will be soluble in water, and precipitated again by alcohol. Resinous bodies are soluble in alcohol, and will be precipitated by water. But in the vast majority of instances, the use of a solution or tincture of galls will reveal the remains of the iron-ink which formed the original writing. If acids have been used to remove the original ink, their presence may generally be detected by the use of litmus-paper, unless they have been neutralized. Modern papers coloured with ultramarine are so changed (the blue into yellow) by acids, that these are scarcely likely to be used. Smalts and Berlin blue admit of acids as bleaching agents. To detect the hidden erased writing, pencil first with weak solution of ammonia, then with the galls solution. The ferro-cyanide of potassium solution sometimes gives good results, bringing out the blue colour of iron-inks, but in this case no ammonia should be used. When chlorine or hypochlorites have been applied freely, almost all inks, except those containing carbon, are destroyed. The ammonia solution is most applicable to iron-inks which have been bleached by acids. Sonnenschein advises a photograph being taken before manipulations. A lens, or careful examination with a compound microscope, will often show which of two writings which cross one another was the first written (in other words, lies in the lower plane). Sometimes the application of a solution, watch in hand, is desirable, to note which strokes are first attacked by the reagent. The last ink often dissolves a little of the first ink, and spreads it out with it, which is best seen at the edges. Sonnenschein (*loc. cit.*, pp. 363—372) gives numerous examples of the detection of fraud.

Note that the water-marks of paper have often proved highly important; and so is the texture, which is best demonstrated by the microscope.

Cryptography, or the art of secret-writing, and its converse, the art of deciphering secret-writing and cyphers, however interesting, is scarcely a subject which comes within the scope of a work on legal medicine.

Marks of Hands, Feet, Boots, &c.

Although the foot-prints and marks left by the hands, or by the boots and shoes of criminals are generally matters of police investigations, yet occasionally the question is referred to a doctor.

Foot-prints in snow, or in soft mud, may be filled up with powdery paraffin, a hot iron passed lightly over (taking care to be well outside the marks), then more paraffin put, and the hot iron applied again; when cool, the paraffin may be removed, and a plaster cast taken. A blood-stain on a wall or the floor might be carefully moistened with a mixture of glycerine and water (1 to 10 or 12) by means of a soft broad brush, and an impression taken on unsized paper of rather rough texture and some thickness, or moistened paper pressed on the marks. You should take opportunities of impressing your feet and hands on soft moist sand, and watch such imprints on the snow, on the sea-shore, on muddy days, &c. You will thus avoid mistakes as to right and left hand impressions, which some medical men have fallen into for simple want of observation. Instead of paraffin, stearic acid in powdery form may be used for snow-prints (Sonnenschein). Plaster casts may be taken direct from sand, mud, &c.

CHAPTER XXII.

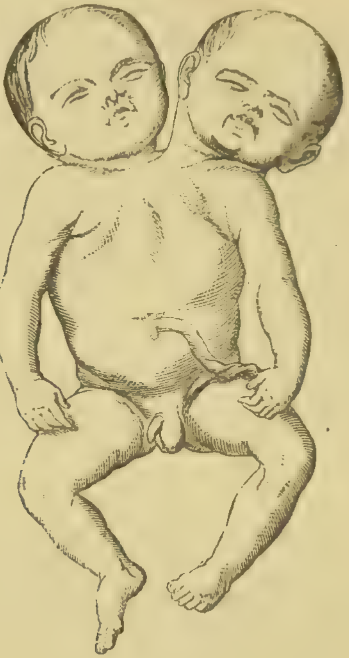
Monsters.—Hermaphrodism—Sexual Incapacity—Impotence and Sterility—Unnatural Crimes—Sodomy and Pæderasty.

The questions arising out of the subjects of this chapter, or at least those likely to be propounded to you, are the following:—

1. Has this monster "the shape of mankind" or not? According to Blackstone no others may inherit, but if there be "human shape," no mere deformity will prevent heirship.
2. Is it male or female, or both in one?
3. If male or female, or both, is it capable of procreating?
4. A wife alleges that her husband is sexually impotent. As the courts allow of divorce on this ground, you may be required to examine the husband.
5. A man accused of unchastity may allege that he is sexually incapable.
6. A husband or wife desiring heirs, may consult you as to the wife's capacity for child-bearing.
7. Mothers whose daughters suffer under some real or fancied malformation of the sexual organs, will consult you as to whether their daughters should or may marry.
8. You may be consulted on the possibility or probability of an heir or heirs being born to an estate when one or both married persons are advanced in life.

The first question is briefly answered in most works on forensic medicine, and we think justly. Mr. Lowne remarks that all deformities known to us may be classed under either—(1) Variation, or (2) Duplicity, or (3) Excess of growth, or (4) Arrest of growth, or (5) Arrest of development, or (6) Disease. The great majority, if not all, may however be included under three headings: (A) Congenital deficiencies of structure, with arrested or defective development and growth of parts [*acephalous*, or headless; *anencephalous*, or brainless; *acardiac*, or heartless monsters, together with the almost endless varieties with deficient fingers, toes, limbs, eyes, ears; deficiency of abdominal walls, hare-lip, cleft-palate, &c., &c., may all be reckoned here]. (B) Congenital redundancy of parts, including the union of two or more embryos. People with six or more fingers and toes, supernumerary nipples, the "Siamese twins," "Two-headed Nightingale," and "Hungarian sisters," and many other examples are properly ranged here, and will readily occur to the mind. (C) Acquired deformities and diseased growth. Goître, club-feet, paralytic and spastic conditions, spinal deformities, loss of limbs in utero, or afterwards, hypertrophic warty or semi-malignant hypertrophy of clitoris, penis, scrotum, &c., belong to this class. The sub-divisions of united or divided parts may easily be referred to one of these three classes. A careful consideration of the specimens in our museums, or figured in works on the subject, has convinced us that very few, if any, of the human monsters *who are capable of living to adult age* can fairly be denied some human shape.* However painful to see, or unpleasant to have, mere want of limbs can scarcely be called monstrosity. A recent member of parliament was born almost entirely limbless, yet, by means of mechanical contrivances, is said not only to be a good shot and a bold horseman, but also to be able to write and paint pictures. Deformities of the sexual organs require more careful consideration, and may even acquire political importance, where, as in the United States, the right of voting is given to all adult males, and eagerly sought for. The sexual organs in males and females may be classed as follows. Analogous and homologous parts in the two sexes are arranged opposite one another, as far as possible:—

FIG. 68.



I. External organs, so called non-essential or less essential.

MALE.	FEMALE.
Mammæ.	*Mammæ.*
Penis.	*Clitoris.*
Spongy portion of urethra.	*Urethra.*
Scrotum.	*Labia majora* and minora.

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* Consult on these subjects Geoffrey St. Hilaire, "Histoire générale et particulière des Anomalies de l'Organisation chez l'Homme et les Animaux." Förster. "Die Missbildungen des Menschen." Sir James Simpson's Article on Hermaphrodism in Todd's "Cyclopædia of Anat. and Phys." Vrolik in 4th vol. "Cyclopædia of Anatomy," and also his "Vrucht van den Mensch en van de Zoogdieren." Dr. Allen Thompson on Double Monsters, "London and Edinburgh Monthly

II. Middle, or, especially in the female, more essential organs.

MALE.	FEMALE.
Cowper's glands.	Duvernay's or Bartholini's glands.
Membranous and spongy portion of urethra.	
Sinus pocularis.	*Vagina, with body and cervix of uterus.*
Vasa deferentia, ejaculatory ducts, and vesiculæ seminales from Wolffian bodies	
Epididymis.	*Par-ovarium* or organ of Rosenmüller.
Hydatid of Morgagni.	Fallopian tubes and upper portion of uterus from Müller's ducts.
Gubernaculum testis.	Round ligament of uterus.

III. Internal, or essential organs.

MALE.	FEMALE.
Testes.	*Ovaria.*

The following Table, from Dr. W. M. Bank's prize-thesis "On the Wolffian Bodies in the Fœtus, and their Remains in the Adult," &c., 1864 [quoted by Dr. Carpenter], gives clearly the origin and homologies of the several parts of the urino-genital system in the two cases :—

The Wolffian Body itself.

IN THE FEMALE.	IN THE MALE.
Fragmentary tubes and canalicules in neighbourhood of par-ovarium.	Organ of Giraldés and vasa aberrantia.

New Structure on Summit of Wolffian Body.

Par-ovarium.	Globus major.

Müller's Ducts.

Ampulla forms fimbriated end of Fallopian tube.	Ampulla forms hydatid of Morgagni.
From ampulla to round ligament forms the Fallopian tube itself.	From ampulla to gubernaculum forms small cysts running from hydatid of Morgagni down side of epididymis.
From round ligament to genital cord forms the cornua uteri.	From gubernaculum to genital cord forms cornua of organ of Weber.
When united in genital cord they form the uterus and vagina.	When united in genital cord they form the organ of Weber (vesicula prostatica).

Excretory Ducts.

Gaertner's canals (in sow, &c., not in human female).	Vas deferens, body and globus minor of epididymis.
Diverticula in these.	Broad and sacculated end of the vasa deferentia.

Journal," 1844. B. T. Lowne. "Descriptive Catalogue of the Teratological Series in the Museum of the Royal Coll. Surgeons of England, 1872," and the "Edinburgh Medical Journal," and other medical periodicals for the last half century (British and foreign).

External Organs.

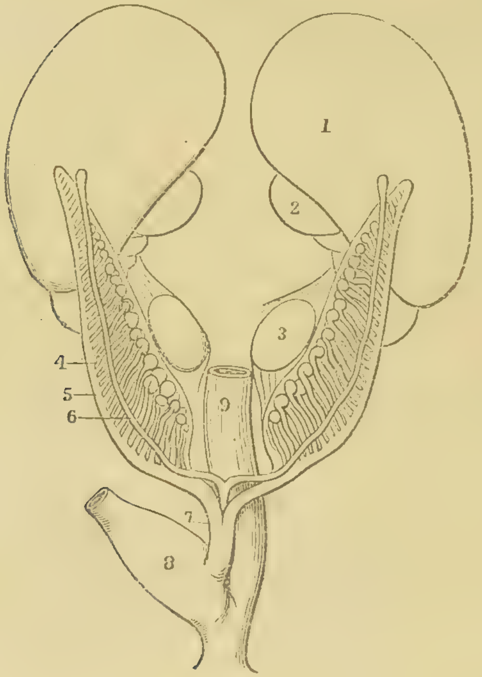
Clitoris.	Penis.
Pars intermedia.	Corpus spongiosum.
Labia majora.	Scrotum.
Bulbus vestibuli.	Bulbs.
Labia minora.	? Cutaneous covering of urethra.

Sinus uro-genitalis.

Vestibulum. Vagina.	Membranous portion of urethra and a small part of the prostatic portion.

There may be slight differences of opinion as to the development of some of these parts, but as regards those printed in italics in Table I., there is a general agreement amongst physiologists. [*See* fig. 69,* explained in foot-note.]. What we know of twins in the human subject, and *à priori* reasoning, would lead us to believe that true hermaphrodism, or the complete union of both sexes in one body, is not only possible, but probable. You are aware that both male and female organs are united in the vast majority of flowering plants, although even here self-impregnation appears to be the exception, one set of organs usually maturing before the other set. Many of the inferior tribes of animals are examples of the same thing. Thus every mature joint of a tape-worm has both male and female organs of generation, internal as well as external, perfectly formed. So have slugs, snails, and many other mollusca and animals included in Cuvier's Radiata and Articulata. When we come to vertebrate animals, particularly the mammalia, we frequently get mixtures of the characters of both sexes which at first sight appear to be true examples of hermaphrodism. Thus when a cow has twins apparently of opposite sexes, the bull-calf is generally all right. The cow-calf, however, never propagates its kind, appears to have no sexual instincts, grows larger than

FIG. 69.



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* Fig. 69 is a diagram of the Wolffian bodies, Müllerian ducts, and adjacent parts, previous to sexual distinction, as seen from before [from Quain]. The figures, to avoid confusion, are single, whilst most of the organs are seen to be double, *i.e.* present on both sides :—1. Supra-renal body : 2. Kidney : 3. Common blastema of ovary or testis = genital gland ; 4. Wolffian body ; 5. Wolffian duct ; 6. Müllerian duct ; 7. Genital cord [=Sinus pocularis in adult male, and vagina and uterus in adult female] ; 8. Sinus uro-genitalis ; 9. Intestine, terminating in cloaca..

either bull or cow, and fattens better. To such the name of *Free-martins* is given. Some of these have testes in lieu of ovaria; sometimes both testes and ovaria appeared to be present. The rest of the organs of these animals present a mixture of the characters of both sexes. In some cases it is probable that the vesiculæ seminales were mistaken for either testes or ovaria. [*See* John Hunter's "Observations on Certain Parts of the Animal Economy," p. 55; "Philosophical Transactions," vol. lxxxix.; "John Hunter's Works," vol. iv., pp. 41, 42]. In vol. xlii. of the "Medico-Chirurgical Transactions," Mr. W. S. Savory describes and figures an hermaphrodite sheep, which was regarded as a ewe during life. Its external genitals resembled those of a ewe; the external orifice led into a vagina three inches long (half average length), beyond which was a two-horned uterus, two-thirds the usual size. In place of the ovaries were two testes (each surmounted by an epididymis a quarter the usual size). There were well-formed seminal vesicles, but no spermatozoa. This animal was, therefore, truly a male, presenting many female characters. These strange beings are well described by Ausonius in these words:—

> "Nominis ut misti, sic corporis hermaphroditus,
> Concretus sexu, sed non perfectus utroque,
> Ambiguæ veneris, neutro potiundus amori."

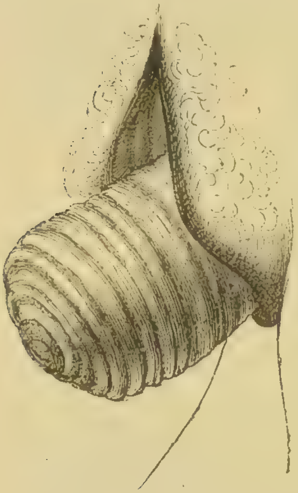
And by Ovid:—

> "Nec duo sunt, sed forma duplex, nec femina dici,
> Nec puer ut possit, neutrumque et utrumque videtur"

The limits of this work will not permit of more than one or two illustrations of each class of hermaphrodites. But attention to these, and care in examination, will prevent your making any serious mistakes, as in any doubtful case it will be better to suspend your judgment. Whenever you attend a labour, or whenever any abnormality in children excites your attention, you should at once examine carefully. In the case of such as an infant dying, a post-mortem examination should be made. Dr. Taylor justly points out that this may be of legal consequence, since, in what is called *tenancy by courtesy*, "a man marrying a woman seised (or possessed) of an estate of inheritance, and having by her issue born alive, and capable of inheriting the estate, holds, on her death, the lands for his life, as tenant by courtesy." But clearly, if entailed on heirs male, or *vice versâ*, and the issue were neither male nor female, or of the wrong sex, he could no longer sustain his claim. According to the preponderance of male or female characters, the names of Androgyn*i*, or womanish men, and Androgyn*æ*, or manly women, have been given. Lord Coke states that according to English law, "an hermaphrodite may be either male or female, and shall succeed according to the kind of sex which doth prevail." It will, however, be seen from the cases cited, that the determination of the prevalent characters is often extremely difficult, for you may have to give an opinion before puberty; and even after puberty, the characters of both sexes may be strangely blended.

I. The case of manly women (Androgynæ) is the simplest. The common forms are—(1) *Enlargement of the Clitoris;* this may be congenital. There is a very good example in the London Hospital museum, presented by Dr. Ramsbotham. Dr. Hills ("Lancet," vol. i., p. 129, for 1873) records a case of a dressmaker, aged 42, in the Norfolk Asylum, with broad shoulders, undeveloped breasts, thick moustache and a full beard. The clitoris was very large, with a distinct prepuce. There were no signs of testicles, and she had menstruated three times, though imperfectly. The lower part of the body was feminine. Beck gives numerous references to congenital and acquired malformation of the clitoris. [*See* also Home on Hermaphrodites, "Philosoph. Trans.," vol. lxxxix., p. 157]. (2) Besides the development of hair resembling the male, as in the case above, there may be *entire absence or imperfect development of the ovaries or uterus, or both.* There are several cases on record in which no trace of either could be found on the most careful examination, and we have ourselves seen such. Note, however, that a beard and whiskers may be present, and yet the general conformation of the body may be feminine; uterus and ovaries may be present, and the person may give birth to children (as in the case of Julia Pastrana). (3) Velpeau suggests that *prolapse of the ovaries may simulate testes* ["Midwifery," American edition, p. 81; *see* also "Lancet," vol. ix., p. 169]. (4) *Loss of one or both ovaries* will produce a more or less manly appearance, changes in the voice, &c. (5) *Prolapse of the uterus* (or rather procidentia) could scarcely deceive any one conversant with midwifery, though in 1693, Margaret Malaure, suffering from this disease, exhibited herself as an hermaphrodite in Paris. (Fig. 70.)

FIG. 70.



I. The case of womanish men (Androgyni) is generally more obscure, but may often be detected by careful examination. The common forms are:—

1. Imperfect development of the penis, generally combined with a cleft scrotum, and often with non-descent of at least one testis. The penis is generally short and clitoris-like, often bound down on its anterior (or lower) surface, and more or less completely imperfortate. If the opening of the urethra is inferior such cases are called Hypo-spadians. If the urethra or bladder opens *above* or on the upper side of the penis, the cases are called epispadians. In extreme cases even the anterior wall of the bladder may be wanting. [On this subject see the remarks on *sterility* in the male, p. 679.] Of hypospadias, by far the most common form, Dr. Graham's case, quoted by Dr. Handyside in No. 213 of "Edinburgh Medical Journal," is a good example. James C——, born at Port Glasgow in 1853, was supposed to be a girl till sixteen years of age. There was a very short clitoroid penis, with hypospadias, a cleft scrotum, with one testis in the right half or labium; the other, supposed to be a rupture, was in the left groin. Gottlieb Göttlich, born in Saxony in 1798, was baptised as Marie Rosine G., was employed as a female servant for some years, and his true sex was never suspected till the spring of 1831, when he fractured his left

femur, and was admitted into a hospital at Dresden. At this time first the left, then the right testis descended, and being accompanied with a strangulated hernia on each occasion, the operations led to the discovery of the testis, and hence of the true sex. His semen had spermatozoa. He was a hypospadian with cleft scrotum. The penis was only one and a half inch in length, and imperforate. [*See* the excellent account by Dr. Handyside in No. 123 of the "Edinburgh Medical and Surgical Journal."] The general appearance was masculine.

2. One or both testes may be undescended, and if atrophied before puberty, the appearance may be very feminine. Early castration may produce similar changes. If the Turkish method of making eunuchs by a clean sweep of the genital organs be followed, a hasty inspection will give the impression of a female.
3. Mere adhesion of the penis may deceive the parents. Mr. Brand, in 1779, operated on such a case, in a boy of seven, regarded as a girl [*see* Brewster's "Edinburgh Encyclopædia," article Hermaphrodites]. It has been said that a similar *liberation* has occurred to the male organ of a supposed girl whilst jumping! Such cases are related by Livy, Shenkius, Montaigne [Essais, l. 20], and Ambrose Paré [case of Marie Germain].

III. Cases of mixed and complex hermaphrodism [which are called *lateral*, when the external organs, of a mixed or doubtful type, are associated with male organs on one side, and female organs on the other side of the median line, as regards the middle and deep or internal organs] are still more puzzling, and sometimes almost impossible to class, either in life or death. Mr. Savory's sheep (mentioned above) is almost eclipsed by Sir Everard Home's bull [" Phil. Trans." 1799], who had begotten five calves, possessed ordinary male organs, had the general appearance of a male, except in the flanks and hind quarters, but had an udder and teats affording milk, and a small vagina capable of admitting the male organ. The case of Lafort ["Dictionnaire des Sciences Médicales," art. Hermaphrodisme] puzzled some of the best anatomists in Paris and London. The chin, chest, and extremities were covered with hair; the breasts were elegantly and perfectly formed. There was a small clitoris, with an imperforate glans. Below, five small openings, through which urine passed. A probe revealed something like a vagina, and she was seen to menstruate. She was supposed to have one ovary and one testis. Catherine Hohmann's case, lately exhibited in the capitals of Europe, is supposed to be a true instance of lateral hermaphrodism. [*See* Virchow's "Archiv," vol. xlv. for 1868, the "Archives générales" for March, 1869, and the " Medical Times and Gazette," 1873, p. 691.] This person, whom we have seen ourselves, is certainly an odd mixture of the sexes. The bony skeleton is masculine. The larynx large, the voice is said to have been feminine till the age of twenty-six. The breasts, even at the age of forty-three, were exceedingly well formed, and feminine. There is a penis, measuring nearly four inches with the glans. It is imperforate. There is hypospadias, and the scrotum is split; the right half contains what all agree is a well-developed testis, with epididymis and vas deferens, and a cremaster muscle. At the bottom of the left half of the scrotum is a hard ill-defined mass, which may be a degenerated testis. In the left groin is another body, which is probably a hernial sac. A probe passed into the short urethra, instead of always reaching the bladder, often passes into a sac-like cavity behind the urethra (uterus?) In examining per rectum some examiners have found a body like an ovary. She or he seemed to have double sexual instincts. The seminal emissions contained spermatozoa. From about the age of ten years there has been periodical menstruation, which was verified by Professor Franck. As an instance of the difficulties offered by some of these cases, and of their forensic relations, take the case of *Levi Suydam* related by *Dr. Barry* in the "American Journal of the Medical Sciences" for July, 1847. In the spring of that year Suydam presented himself first as a free*man*, and then to vote in a contested election. Dr. Barry having found an imperforate penis, with a depression in the site of the male meatus, a short urethra opening underneath the penis (hypospadias) and a cleft scrotum, with a small but perfect testis in its right half—pronounced him to be a male, and entitled to vote. Dr. Ticknor, who objected at first, came to the same conclusion. A few days after it was discovered, by his sister's and his own confession, that Suydam regularly menstruated ! and had done so for years ! His figure was feminine—the breasts were well developed—and on passing a sound into the urethra, instead of reaching the bladder, it passed into a cavity like a vagina three or four inches deep. It was also said that this urethra had been made for him by the accoucheur who attended at his birth ! Dr. Taylor justly objects to the removal of two imperfectly developed testes in the case of a girl-like boy whom Dr. Gross castrated [*vide* "Taylor," *loc. cit.* ii. p. 285]. Instances of double vagina, double uterus, two distinct penes, and three testicles are also on record ; but as there is, so far as we can find, no perfect instance of both male and female (external) organs of generation combined—we mean a perfect set of each—the cases mentioned appear only to intensify the sex, or to be curiosities. The double or two-horned uterus may, however, account for cases of superfœtation.

Amongst the curiosities of doubtful or concealed sex may be noticed the case of *Eliza Edwards* ["Medical and Phys. Journal," Feb., 1833, p. 168], who, although a male, passed for a female, and had been attended by an eminent physician in his last illness without any suspicion of the truth. Indeed, the body was sent to Guy's dissecting room as a female. Dr. *James Barry*, late Staff-Assistant Surgeon and Inspector of Hospitals, who had served many years in the army, and even fought at least one duel, was a female !

The celebrated Chevalier d'Eon was undoubtedly a male, though long believed to be a female, and wearing feminine apparel for many years by order of Louis XV. of France. The records of the army and navy supply numerous instances of concealment of sex, and the popular ballad of "Billy Taylor" is undoubtedly founded on fact.

In endeavouring to form a decision in doubtful cases, the following facts may be of some assistance :—1st. An analysis of recorded cases shows that in infants the probabilities are greatly in favour of the male sex in all doubtful cases. 2nd. As regards adults, regard should be had to the general conformation of the skeleton ; in the male the shoulder should be wider than the hips ; the development of muscles is usually greater than in the female (though we have seen a female carry easily a sack of flour on her shoulders) ; the so-called sexual hairs extend higher towards the umbilicus in the male ; the distance between the pubes and the umbilicus in males is shorter than between the umbilicus and the scrobiculus cordis, whilst the reverse is the case in females [Dr. Handyside]; in the male the pomum Adami is more developed, and the larynx larger. In the female the hips are broader, the thighs shorter and bigger, and the tuberosities of the ischia and the acetabula are wider apart; the gluteal region is flatter in the female. As regards the breasts, more regard should be had to the development of the glands and nipples than to mere size or adipose growth. 3rd. If doubt arises as to a body, say in the groin, or in one labium or half of a cleft scrotum, as to whether it be a testis or an ovary, Professor Virchow points out that the harder such a body is, the more likely to be an ovary, since the ovary is largely composed of a fibrous stroma; whilst the softer it is, the more likely to be a testis. 4th. Although mental characters and sexual proclivities may be allowed a certain weight, yet we must remember the influence of habit and education, and that sexual feelings may arise between individuals of the same sex, more especially when in ignorance of their true condition. 5th. If no spermatozoa are found in so-called *seminal emissions*, we must look on these, in the absence of well-marked male organs, as extremely doubtful. 6th. In the same way, mere statements as to menstruation must be received with extreme caution. We should have the menstrual molimen, as well as a periodical hæmorrhage.

Impotence and Sterility.

In answer to Question III., "Is he or she capable of procreating children," you must not forget that, although there can be no doubt that the great majority of so-called hermaphrodites are sterile, yet in ancient times some of them were burnt for getting women with child, and that in modern times spermatozoa have been found in the seminal secretions of some of the cases recorded above. This introduces us to the more general question as to the causes and proofs of sterility and impotence in both sexes. It would appear that, strictly speaking, English law draws no distinction between the absence of power for sexual intercourse and sterility or want of fruitfulness. Yet in reality there is a very real distinction between the two, which is clearly recognised in our courts in trials involving the succession to estates and questions of legitimacy. In this respect Dr. Guy is logically correct in separating the two subjects. But it seems better for practical purposes to follow the common legal custom, and do as Dr. Taylor does, regard impotence in the male and sterility in the female as correlatives.

I. The question of impotence in the male may be raised by a wife as a ground of divorce. In this case the law requires that it should have existed *ab initio*, that is, before the marriage, and should be of an incurable nature; marriage being very properly, as far as the law goes, regarded as a contract between the two parties, in which it is pre-supposed that both are capable of fulfilling all the objects of marriage. Such suits were far more common formerly than of late years. In the reign of King James 1st of England, the Earl of Essex was sued by his countess for divorce on the ground that he was impotent. She claimed to be a *virgo intacta*, but is said to have substituted one of her maids for herself when examined. The earl appears to have admitted the charge as regards the countess, although he denied it *quoad* others. The case is complicated by her guilty passion for Rochester. [Hargrave's "State

Trials," i. p. 315.] II. Impotency is frequently alleged as a ground of defence against accusations of rape or indecent assault; for the most part falsely. III. Impotence in a husband may be produced as a proof of the bastardy or illegitimacy of a child, or children, and simultaneously as a proof of unchastity in a wife.

Casper justly remarks that in examining persons supposed to be impotent it is as unnecessary, and indeed useless, as it is indecent to attempt any testing of the virile powers by manipulations of the genital organs. If these are well-formed and healthy, and the general health be good, we ought to assume that there is capacity for sexual intercourse "with the usual limit of age." As he says, "*the possession of virile and procreative power neither requires to be, nor can be, proved to exist by any physician,*" but is rather, like every other normal function, to be supposed to exist. From the 13th century to the year 1677 the laws of France and some other European countries allowed of, and even ordered, methods of ascertaining sexual capacity, which are now known to be as useless as they were disgusting. The complaining parties were examined minutely by witnesses who were also judges in the case, and the husband had then and there to prove, if he could, his disputed capacity [*vide* article "Congrès" in the "Dictionnaire des Sciences Médicales."] It seems to have been abolished in consequence of a Marquis de Langley having failed to prove his powers in such a congress, but getting seven children by a second wife, after his divorce from the complainant. The distinction between mental and physical causes of sexual capacity does not appear to us to be well-founded, at least in the class of cases likely to come to trial.

1st. The absence of the usual signs of puberty, in other words extreme youth, must be regarded as a cause of impotency. Our law recognises fourteen in the male and twelve in the female as the earliest age at which marriage can be contracted. The age of fourteen for both sexes is the Ecclesiastical law of both the Eastern and Western churches. Eighteen for males and fifteen for females was fixed by the Code Napoléon. Twenty and sixteen years respectively are fixed by the New German Civil Marriage Bill. Although puberty for both sexes may be taken to commence somewhere about fourteen in both sexes, yet physiologists know that there are many exceptions to the general rule. Puberty is often deferred in both sexes, whilst occasionally it is *anticipated.* Instances of retardation are familiar to every medical man in practice, whilst very singular instances of precocious puberty may be found in medical authors. Two of these may be quoted from the "Medico-Chirurgical Transactions." The first [from voi. i. of these, pp. 276—285] relates to Philip Howarth, born in 1806, who attained to puberty in his second year. The case is carefully reported by Dr. White, assistant-surgeon to Westminster Hospital. The virile changes involved the larynx and musculature as well as the genital organs. Older writers give still more wonderful cases, but these are less reliable because less detailed. Dr. Mead speaks of a boy achieving puberty when only one year old. [*See* also "Phlegon, de Mirab." cap. xxxii.] In the second vol. of the same "Transactions," p. 116, &c., Dr. Wall writes to Dr. Matthew Baillie an account of a girl who, when scarcely two, was as developed as one of eighteen would ordinarily be. She first menstruated at nine months of age; the mammæ were well-developed in her second year, &c., &c. Another instance is recorded by Sir Astley Cooper, in vol. iv., p. 204, of puberty in a girl aged between three and four years. Such cases, however wonderful, have little bearing upon special inquiries, except in so far as they show that too much importance must not be attached to age *per se.* If we find unequivocal signs of puberty in a boy, however young, we are, *cæteris paribus,* to consider him virile; whilst if these be absent, even at the age of twenty-five or more, we have no grounds for affirming the possession of a power which does not manifest itself as usual.

2nd. Defect or malformation of the sexual organs may be the cause of impotence. Under the heading of Hermaphrodites we said that most of these beings were sterile, and very many are impotent. There are, however, beings in whom there are, properly speaking, no organs of generation at all—"sexless things." Neither male nor female organs were present in a case reported by M. Tardieu, in the "Annales d'Hygiène," 1872, ii., 149. [*See* "Taylor," vol. ii., p. 281]. It is not easy to lay down any precise rules as to the *amount* of injury or damage, short of entire destruction of the genitals, which would cause absolute sterility, but (A) entire *absence of the penis* would certainly be a cause of impotence, although not necessarily of sterility. The same may be said of extreme degrees of *hypospadias* and *epispadias.* As regards minor degrees of these, particularly of the former, there are numerous instances of the transmission of these defects. Dr. Woodman had a case brought to him at the N. E. Children's Hospital in which, for four generations, there was hypospadias. The defect descended on the male side only—in other words, the male children of the *sisters* were well-formed. Belloc ["Cours de Médicine légale," &c., p. 50], mentions a similar case. *See* references in Beck (*op. cit.*, p. 52). Epispadias is so often mixed with absence of the anterior wall of the bladder, that disgust on the part of the female would probably be a cause of incapacity. Dr. Taylor justly remarks that in the presence of any intromittent organ, however small, we should be extremely cautious in pronouncing any opinion as to the possibility of sexual intercourse—in other words, of pronouncing a man to be impotent or sterile. (B) *Absence of the testicles* (as in castrates) is unquestionably a cause of sterility, though there seems a general consent amongst legal jurists as to the possibility of fruitful intercourse within a few days of such emasculation. This opinion is a very ancient one, and is supported by a few facts observed in animals, and by one or two cases said to have been noted in human beings. Thus Varro ["De re rusticâ," vol. ii., p. 5, quoted by Dr. Elliottson] says, "Exemptis testiculis, si statim admiseris, concipere (vaccas)." *See* also Sir Astley Cooper's "Observations on the Structure and Diseases of the Testes," p. 53, sq. 40, London, 1830. A case of impregnation after the husband had lost both testes by a gunshot wound is reported by Dr. Krügelstein, in Henke's "Zeitschrift," 1842, vol. i., pp. 348 and 352, quoted by Dr. Taylor. Some semen may be retained in the seminal vesicles and ducts. But we confess the evidence seems to us very imperfect. If a small portion only of secreting structure (seminal tubes) were intact, and in communication with the ducts, it is quite clear that spermatozoa may be formed. We think, however, that the power of copulating has been confounded with the fecundative act. That eunuchs, or at least some eunuchs, possess the former to a great degree seems generally admitted. [*See* "Juvenal," *passim.*] On the other hand, there seems reason to conclude from numerous cases recorded by Dr. Taylor, and others, that *monorchids* (those with only one testicle, or with only one descended into the scrotum), and *crypsorchids* (or those in whom both testicles have retained their lumbar or abdominal position—in other words, both testes are absent from the scrotum), may both be capable of begetting children. Mr. Curling states that in monorchids he has only found spermatozoa in the fluid of the testis which had descended. Mr. Partridge and others confirm this by asserting the absence of spermatozoa in all cases of crypsorchids examined. [Consult M. Godard's "Etudes sur la Monorchidie et la Cryptorchidie chez l'Homme," 8vo., pp. 164, Paris, 1857; also, Review of ditto in "American Journal of Medical Sciences," Jan., 1859; also Messrs. Goubaux and Follin's Memoir, "Sur la Cryptorchidie chez l'Homme et les principaux Animaux domestiques;" and "Observations on Sterility in Man," by T. B. Curling, F.R.S. (who quotes nine cases of absence of spermatozoa in human semen in cases of retained testes); also "British and Foreign Medico-Chirurgical Review," April, 1864]. On the other hand, Casper found spermatozoa in the seminal fluid of a crypsorchid. And although John Hunter conceived that such beings were necessarily sterile, yet looking at the facts of comparative anatomy, we think the question may be summed up as follows:—The majority of those whose testes are both undescended, are sterile, but not impotent, whilst there are some who are not either—or, in other words, are perfectly virile. *Supernumerary testes* (of which there seems scarcely any authentic instance in modern times), and supernumerary penes, are no bar to sexual intercourse, though the latter may increase its difficulties. In a recent case exhibited in London there were two penes, but two testes only. (C) *Advanced disease of the testicles or penis,* whether syphilitic, cancerous, tuberculous, or of any other nature, may of course be a bar to sexual intercourse, or a cause of sterility in the male. [*See* Cautions, at end of this section].

3. Complete *Paraplegia* might, and probably would, also hinder sexual intercourse taking place or proving fruitful. Instances are, however, on record of partial paraplegia, and of hemiplegia, in which sexual intercourse occurred notwithstanding. In the case of *Legge* v. *Edmunds,* heard before the Vice-Chancellor in 1854—5, a posthumous child, born four months after death of the reputed father, who had been attacked with coma, and right-sided hemiplegia two months before the supposed date of conception, was adjudged legitimate, though there were some very suspicious circumstances in the case, and no child had been born for eight years before. Dr. Taylor considered the paternity possible, but improbable. Drs. Guy and Semple strongly maintained the possibility and probability. Locomotive ataxy and other nervous diseases are also known to produce this.

4. *Injuries to the head or spine have produced impotency.* (*See* Curling on "Diseases of the Testes," 2nd edit., p. 362).

5. Very advanced disease of almost any kind, and extreme physical weakness, may produce impotency and sterility. Diabetes is usually accompanied with impotency. On the other hand, the Authors know of cases of advanced heart and lung disease (phthisis),* in which coitus (followed by the birth of a child resembling the father) took place only a few hours before death.

6. The mere fact of *old age* does not in itself involve *sexual incapacity,*

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* Spermatozoa were deficient in twelve cases of phthisis examined by Mr. Curling, while Dr. Davy found them in the vesiculæ seminale in some cases.

though it renders the occurrence of paternity far less probable than in earlier life. Mr. Curling has found spermatozoa in the semen of very aged men. Casper once in the case of a man ninety-six The Authors also have two or three times found them in the seminal fluid of men over ninety. M. Dieu, of the Invalides, states that in 105 autopsies of men between 64 and 107, there were no spermatozoa in 61 per cent. Old Parr was believed to have begotten a son when he was 140 years of age. In the celebrated *Banbury* peerage case, decided by the House of Lords in 1813, Sir Samuel Romilly stated that the law of England admits no (advanced) age at which a man may not become a father.

7. *Lithotomy sometimes induces sterility in the male. See* a Paper by Mr. W. F. Teevan ("Trans. Chir. Society," vol. vij., pp. 179, 180, and "Trans. Path. Society," vol. xvij., p. 186), narrating four cases of lateral lithotomy. In only one case had there been pregnancy in the wife after the operation on the husband, and that was within three months after being lithotomized. In none of the four cases was there any emission in coitu. He explains it by "laceration of the floor of the prostatic urethra, the ejaculatory ducts being torn across, or getting plugged in the healing process." It is possible that other surgical operations (as for hernia or hydrocele) may lead to sterility or impotence.

8. On the authority of Foderé, Lang, and Sir Astley Cooper, *Mumps* or *Cynanche parotidea,* has been said to cause wasting of the testes, and sometimes of the ovaries, and thus to induce sterility and impotence. Cases of orchitis or epididymitis, after Measles and Mumps, are not very rare, but in this country, at least, such an extreme atrophy of these organs as would cause complete sterility must be regarded as very uncommon.

9. *Certain poisons,* notably *alcohol, opium, tobacco, lead,* and *gonorrhœal virus,* are all said to produce sterility. The former by producing general debility, loss of nervous power, or wasting of the testes or ovaria ; the latter by producing *stricture of the urethra,* or blocking of the seminal ducts. A similar temporary effect has been ascribed to *Camphor* and *Coffee,* apparently on very insufficient grounds. "Camphora per nares, castrat odore mares." ["Schol. Salerno," confirmed by Trousseau and Pidoux]. Iodine and the iodides are said to cause wasting of the testes in the male, and the breasts in the female.

Impotence and Sterility in the Female.

Permanent sexual incapacity in the female is extremely rare, except as a consequence of age or disease. For the only likely causes of such a condition existing *ab initio,* or from birth, are the *entire absence of Uterus, or Ovaries, or Vagina—or of all three.* As regards a Uterus, notwithstanding the dictum, *Propter uterum est mulier,* extra-uterine fœtation shows that the organ is not essential to pregnancy. There are several instances known in which a Vagina has been made by surgical art—and the entire absence of both ovaries can scarcely be proved during life, although it may be inferred from outward appearances.*

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* The effects of castration in males, and removal of the ovaries in females, vary according to the age at which the operation is performed, *i.e.*, whether before puberty or after. A boy, if emasculated, grows fat; his muscles are soft, his voice and appearance are feminine, the larynx never enlarges as in the adult male, the

In a valuable paper on "Some remediable causes of Sterility," Mr. Spencer Wells gives the following as the causes of barrenness in the female :—

"1. The ovaries may not perform their normal function of periodical ovulation : in other words, there may be no ova prepared for impregnation.

"2. Alterations in the coverings of the ovary may interfere with the escape of the ovum.

"3. The ova may escape from the ovary, but may not be grasped by the fimbriæ. They generally perish ; or if impregnated, we get extra-uterine fœtation.

"4. Alterations in the Fallopian tubes may obstruct the passage of the ovum into the uterus.

"5. Alterations in the uterus, or in the vagina or external organs, may prevent impregnation of the ovum (1) by preventing access of the spermatozoa to the ovum ; (2) by destroying the spermatozoa by admixture with abnormal fluids, or (3) in some other way interfering with the physical conditions of fecundation."

Under this fifth heading he enumerates : *inter aliis*—

Occlusion of Vagina { By adhesion of labia.
  ,, imperforate hymen.
Diseases of the Vulva (Eczema, Herpes, &c.).
Hyperæsthesia and anæsthesia of the Vagina.
Diseases of Rectum, Urethra, and Bladder.
Ruptured Perinæum.
Vaginal and Uterine Leucorrhœa.
Diseases and displacements of the Uterus.
Contraction of the Os and Cervical Canal.
Foreign bodies and tumours in the uterine cavity, including, of course, Cancers, Polypi, Fibroids, &c.

Now it will be seen at once, that a very large proportion of these causes are curable, or not likely to exist *ab initio.*

Paraplegia in the female does not always prevent either impregnation or delivery.

Unnatural Crimes—Sodomy—Pæderasty.

The references to these subjects in the Old and New Testaments, in the Nouthetikon or Admonition of Phocylides, and the poems of Martial, Catullus, and other ancient writers, show that in every age, especially in populous places, aberrations of the sexual passion of the most horrible kinds, have been more or less prevalent. As however only two of these, Sodomy and Pæderasty, are known to English law, we shall only treat briefly of these, especially as Tribadism, Irrumation, Fellation, Cunnilingus, and Coprophagia leave no certain signs on the body of either of the guilty parties. The authority, indeed, of Parent-

growth of the beard is hindered or prevented ; and there is an absence of manliness of character. In adults there is, in addition to sterility, an absence of sexual desire in most cases, general loss of power, and a squeaky voice. In women who have lost the ovaries there is a loss of sexual appetite, the growth of a beard, the voice becomes harsh, the whole appearance manly, the breasts waste, and in general the body is thinner.

Duchalctet has been cited to prove that the so-called Lesbian love produces enlargement of the clitoris and other changes in the female genital organs. The Authors, however, know of none which are characteristic; in other words, natural conformation, disease, want of cleanliness, and self-abuse, may produce changes of similar characters to those described. With regard to Sodomy and Pæderasty, they are punished with death, according to the statute-books of this and most civilized countries. Owing, however, to the difficulties of proof, and the fact that worthless characters sometimes accuse innocent persons of these crimes in order to extort money, this extreme penalty is seldom enforced. We think it right to repeat the caution of Beck, which, indeed, applies to many other matters—that a Medical witness should not state that such and such a crime has been committed, but should depose to the facts of certain appearances, &c., and state whether they are consistent with the commission of the crime.

As regards that form of Sodomy known as Bestiality, or unnatural connection of human beings with the so-called "lower animals," we are of opinion that the only medical evidence, in either sex, which is of the slightest scientific value, must consist in the finding of Spermatozoa on the person or clothes of the man or woman concerned, or on the hairs of the animal. There can (as Casper justly says) be seldom or never any chance of finding spermatozoa in the vagina of an animal, but they do adhere, with wonderful tenacity, to hairs. The hairs themselves, found adhering to stains of blood, mucus, or semen, on the under-clothing, might furnish *corroborative* proofs. It is well known that almost every animal has characteristic spermatozoa, and a practised microscopist could, in many instances, determine whether these were human or not. On the other hand, it must be remembered that human spermatozoa differ considerably in size, and even in outline, according to the age, vigour and other qualities of the person from whom they are derived. In the case of a female, if seen quickly after the event, there might also be excoriations, or other signs of rape. But this is extremely doubtful.

Very extraordinary evidence has sometimes been tendered in courts of justice ["Tardieu sur les Attentats aux Mœurs," 6 ed. p. 15] with a view to prove the impossibility of such unnatural connections. In our opinion such evidence has no scientific value whatever.

The recent trial of Boulton and Parke [Queen's Bench, 1871] was for "conspiracy to commit or to incite to the commission of immorality." The prisoners had assumed female names and attire, and had frequented theatres and other places of amusement, as was supposed for criminal purposes. The medical evidence was conflicting, and the prisoners were discharged with a verdict of not guilty. The details given by Casper and Tardieu render it probable that this crime is still very prevalent in large cities. In the case of *Wiseman,* prosecuted by the Crown, it was held by the majority of the judges that unnatural connection with a woman came within the statute. Both parties to the crime are held equally guilty, but one may be admitted as a witness against the other. Boys under fourteen, and girls under twelve, are not held to be consenting parties. The remarks as to sleep and consciousness, made under the head of Rape apply here with tenfold force—as do those on consent and resistance. The division of male criminals into active and passive is more curious than practical, since those addicted to the crime usually alternate characters.

The principal facts bearing on the subject may be briefly stated as follows:—

1. Appearance and habits of the criminals. They are usually of feminine appearance, and strive to appear like women. To this end they wear their hair long, curl and part it in the middle; remove superfluous hairs, and conceal or destroy such virile appendages as beard, whiskers, or moustache. They wear female dress, even including stays, and a profusion of jewellery; they use paint, perfumery, and padding:—

"Son teint, reluisant de pommade,
Par le carmin est embelli.
On le devine quand il passe,
Autour de lui l'air est ambré,
Ses cheveux bouclent avec grâce,
Son habit presse un dos cambré.
Comme une coquette un peu grasse,
Dans un corset il est serré."—*Béranger.*

If the crime has been habitual, there will be the usual evidences of sexual excesses, in premature decay of strength, and the apparent age will exceed the real. They generally affect the society of those of their own sex, and as usually hate that of the female sex. Their pose is often statuesque, like that of those addicted to masturbation.

2. The parts of generation are generally much relaxed, the scrotum pendulous, the penis elongated (and it is said that the glans is more than usually bulbous and conical, and the urethra twisted ? ?). The natural folds about the anus are said to be obliterated, giving the skin of that part a smooth appearance, and there is a horn-like, or funnel-like* depression of the nates towards the anus. The anus itself is often gaping, the sphincter relaxed [there may also be fistulæ, piles, and procidentia or hernial protrusions—but of course these are mere accidentals].

3. There may also be excoriations on the parts of generation, and at the verge of the anus, and primary or secondary syphilitic lesions may be found there. As regards the latter, we have so often found mucous tubercles and other specific lesions of the anus associated with hereditary syphilis in young subjects, that we think very great care is necessary in distinguishing the nature and duration of supposed syphilitic chancres in this situation.

Summary.—It will be seen that there are no very certain signs of this crime. Casper and Tardieu rely most upon the funnel-shaped depression between the nates, and the smoothness of the skin about the anus. Both admit, however, that these may be absent, even in criminals like the notorious Count Cajus.†

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* Casper calls it "trumpet-shaped."

† See also Rosenbaum, "Die Lustsuche im Alterthum." Halle, 1839, 8vo; Dohrn, "Zur Lehre v. d. Pederastie in Casper's Vierteljahrschrift," Bd. iv. s. 193; Casper's "Forensic Medicine," N. Syd. Society's translation, vol. iii.; Tardieu, "Etude Médico-légale sur les Attentats aux Mœurs," 6 ed., Paris, 1873 [p. 200 of this contains other references to books]; Taylor, "Principles and Practice of Medical Jurisprudence," vol. ii. p. 472, and 2nd edition; Beck, "Elements of Medical Jurisprudence," 5th ed., p. 110 [References in foot-note to "Zacchias," Foderé, and Mahon].

CHAPTER XXIII.

Pregnancy—Period of Utero-gestation—Signs of recent delivery in the living, and in the dead body.

Some great authorities state that the question of pregnancy in the living is one that seldom comes within the domain of medical jurisprudence. This may be so as regards the Superior Courts, but our experience is rather the reverse, as regards criminal proceedings, and actions for Mala-praxis. Your opinion may be asked in the following cases :—

1st. A woman who is condemned to death for murder may plead that she is with child, as Miss Edmonds did in the Brighton poisoning case. She was not so, but cases have unfortunately occurred, in which a pregnant woman has been hanged. This issue is generally tried by a "Jury of Matrons," but usually a medical man is consulted in addition, and properly so, as there is no subject on which average women display more ignorance than on this question.

2nd. A lady may assert that she is pregnant with an heir to an estate, her husband being recently dead.

3rd. A girl who has been seduced may assert her pregnancy as a reason for increased damages.

4th. A married woman, to please her husband, or for some other motive, may make a similar assertion. The same statement may be made by a lunatic or religious impostor, like Joanna Southcote.

5th. The plea of pregnancy may be (rightly or wrongly) set up as an excuse for non-attendance at a trial. Will. 4, cap. 22, s. 6.

6th. An accusation of pregnancy may be made against a single woman, a widow, or a married woman living separate from her husband. This may furnish grounds for an action for libel or slander, or for proceedings in the Divorce Court.

7th. Accusations of Mala-praxis may be made against a Medical man or other persons, on the ground that he or they have mistaken pregnancy for some other condition, or attempted to bring on Abortion.

In the case of a dead body, the question of pregnancy may be important.

1st. As furnishing a motive for murder [case of Tawell].

2nd. As a probable motive for suicide.

3rd. The question of heirship may arise, because a pregnant woman, under certain circumstances, may be less likely to survive than one who is not with child.

Cautions as to the Diagnosis of Pregnancy.

There is probably no subject in the whole domain of medical practice on which so many mistakes have been made as in the diagnosis of pregnancy. For the most part these mistakes are easily avoidable by attending to the following cautions :—

1st. Never rely on a single symptom; not even on so marked a sign as the sounds of the fœtal heart. The auditory nerves may be deceived as well as the optic. It is seldom safe to pronounce on the authority of less than three or four of the supposed symptoms.

2nd. In the majority of cases, it is not possible to be absolutely certain of the existence of pregnancy before the 6th or 7th month of utero-gestation, although you may often be correct at a much earlier date.

3rd. Never be satisfied to give an opinion without a complete and careful examination of the case. In any doubtful case, as when pregnancy and disease are combined, it is better to seek and obtain a second, or even a third opinion.

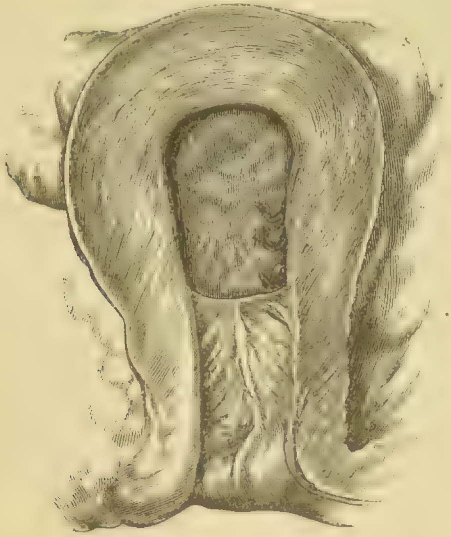
4th. No reliance (for legal purposes) is to be placed upon the feelings or fancies of the woman, nor on the accounts given you by herself, or by her friends. Your reliance must be upon "physical signs." The saying of Gooch that " Women's bellies and not their words, are to be believed," however coarse, is but simple truth; since, however honest their intentions are, they may be deceived. Respectable married ladies who have had many children, often deceive themselves. What wonder then, if a woman who has never had a child, should make a mistake, more especially when she may have most terrible temptations to induce others to believe her pregnant or the reverse?

5th. Let your examination be thorough, and, if possible, in the presence of a witness. Observe great gentleness, and as much delicacy as you can. Medical men sometimes forget that they have no right, merely because they have a medical qualification, to examine a woman *against her own consent*, merely on the verbal order of a policeman, or even of a magistrate ; nor, indeed, even on a written order, except in the case of a prisoner. It is seldom that the accused person will refuse to undergo such an examination, if her consent be asked, but we have known a rough and hasty examination followed by an action for damages, because a medical man forgot the necessity of this præ-caution. This remark applies equally to cases of rape, criminal assaults, and alleged delivery.

The principal symptoms of pregnancy are (1) Cessation of the Catamenia ; (2) Morning-sickness ; (3) Changes in the Breasts; (4) Enlargement and other abdominal symptoms ; (5) Changes in the Uterus and Vagina; (6) Symptoms belonging to the fœtus and placenta ; (7) Alterations in the secretions, such as salivation, changes in the urine, &c. As these symptoms are by no means of equal value, or equally easy to recognise, we shall discuss them separately.

I. *Of the Cessation of the Catamenia.*—The rule, of course, is that you will find the catamenia suppressed for as many monthly periods as the woman is months "gone with child." But remember: First, that a woman may have periodical hæmorrhages all through pregnancy, and that these are very common in the earlier months without any placenta prævia in the true sense of the term : Second, that some women conceive without ever having been " regular " or " poorly " at all, and cases are recorded in which women never had any appearance of monthly discharges except when they were pregnant.* Remember also that the Catamenia may be suppressed from cold, from fright, from phthisis, from anæmia, and other causes. Also that a woman may either conceal the occurrence of menstruation, or may purposely stain her underclothing with the blood of other animals, or with pigments closely resembling blood in colour; and remember also that stains upon clothes or bedding

FIG. 71.



UTERUS OF WOMAN who died from apoplexy during the catamenial flow. The whole of the mucous membrane of the body of the uterus is wanting.

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* The Catamenia, Menses, "monthlies," or "poorly times," usually occur from the period of puberty till the cessation of active sexual life, in the vast majority of the female sex, at pretty regular intervals of one lunar month, or 28 days, reckoned from the beginning of one such hæmorrhage to the beginning of another, and coincide physiologically with the discharge of unimpregnated ova from ripened Graafian follicles. The catamenial discharge is for the most part blood but little altered in composition, though Dr. Letheby and others assert that the fibrin is greatly lessened or absent, thus accounting for the rarity with which it forms a firm coagulum. It is, however, generally altered in colour, from admixture with the secretions of the Vagina, and more or less mixed with epithelial scales, and other matters from the uterus, vagina, or external parts. In some women there is a complete "moult," recognisable by the microscope, from the whole of the urino-genital tract. This flow may vary in quantity from a few drops to many ounces, from four to eight ounces being very common, and it may last only a few hours or several days, from three to four and a half days being a common "period." The apparent *interval* being thus only 25, 20, or even less days. Some women are said to menstruate, or "be poorly," or "have the flowers" at intervals of only fourteen days, and very rarely, of only seven days. Many causes may retard their flow by a day or two, or may cause it to be anticipated. Mr. Robertson's researches have shown that the average for the commencement of menstruation is 15·204 years. Our own experience gives 14·36 years, whilst Mr. Whitehead found that in Manchester, in a large number of cases, it was not established till the 16th year; whilst cases are on record of children born with the signs of puberty, and menstruating when they were nine months old ["Med. Chir. Transac.," vol. ii., p. 116]. Numerous cases of retarded menstruation, not beginning till the 20th or 26th year, or even later, are also on record.

Many of the supposed cases of early or precocious menstruation are undoubtedly spurious, and all cases in which the other signs of puberty are absent must be regarded as doubtful. M. Brière de Boismont found the mean age of first menstruation in Paris to be 14 years and 6 months, whilst in small towns it was 14 may be due to other hæmorrhages, as, for instance, from piles, and that hæmorrhages may also proceed from polypoid or fibrous tumours of the uterus, from vascular tumours of the Meatus urinarius, from a boil, abscess, or the like.

The practical conclusion you will draw from all this is, that the presence or absence of the catamenia is, in itself, of very little value in the diagnosis of pregnancy, although taken with other symptoms, their absence may assist us in the diagnosis. We have, however, dwelt at some length on this topic, because it is of importance in other ways.

II. *Morning-sickness.*—Pregnancy is often accompanied by many derangements of the digestive organs. From the 2nd to the 6th week after conception is the most common period at which these occur, and they generally decline about the 4th month. "Morning-sickness" is the most important of these in a diagnostic point of view. This generally occurs, only on first rising in the morning, or on assuming an erect position, and is very often limited, as the name implies, to the morning hours. As a rule, the general health, appetite, and nutrition, are but little affected, although in exceptional cases life itself may be imperilled. It is important to remember that renal, gastric, cerebral, and cardiac disease may give rise to nausea, vomiting, and other dyspeptic symptoms. "Morning-sickness" is also common in dram-drinkers. So that taken by itself, this symptom also is worth very little, but in young and healthy primiparæ it may often give valuable indications, taken in conjunction with other symptoms.

III. *Mammary Changes.*—The breasts grow larger and heavier concurrently with the growth and development of the Ovum. Part of this increased size is doubtless due to adipose tissue, but the most characteristic changes are the increased size of the true breast, or gland tissue ; and the most marked visible signs are the change of colour in the areola of the nipple, and the increased size of the follicles in that areola. At the same time the veins become enlarged and prominent. All these changes are most conspicuous in a first pregnancy, and are best seen in women with clear complexions, with a moderate amount of pigment in the skin. The general impression is better conveyed by the coloured illustration than by any verbal description. If you wish to examine the breasts for Medico-legal purposes, it is very important to look at them first, before touching them. The whole bosom should be uncovered. The changes about to be described begin with the beginning of pregnancy, but are clearly perceptible at the end of six weeks or two months. There is then a decided darkening around the nipple. You must not forget that there is always an areola or coloured circle varying from a pink in very fair women, to brown, or almost black, in darker people—but its size is greatly increased by pregnancy—its diameter ranges from one half to two or three inches. Upon this dark ground there is a double or triple row of follicles, or tubercles of the areola, which are in reality miniature nipples. Their lighter colour strongly contracts with the dark ground on which they lie—their number varies from twelve to about

years 9 months, and in the country 14 years 10 months. It is generally supposed to occur earlier in towns than in the country, and in hot climates than in cold ones. Dr. Norman Cheevers, however, does not hold this to be generally true as regards India, except when the sexual passion has been unduly stimulated at early ages. The catamenia usually cease from the 42nd to the 48th year ; but this, like the period of their commencement, is very variable.

twenty—and their size is much increased by pregnancy. Besides this, towards the end of gestation, there are small whitish spots on the outer part of the areola, presenting an appearance as if the colour had been discharged by a shower of drops falling on the part. [Secondary areola of Dubois.] Dr. Montgomery attributes great importance to these, as a sign of pregnancy. The nipple becomes more prominent, and tinged, and often has branny scales, from the drying-up of a milk-like fluid which now begins to be secreted. The breast becomes firmer, larger, and more knotty in feeling. Care should be taken not to handle the breasts much—or the observer may easily be deceived by the physiological congestion thus produced. It is the first impression given to the touch which is of value. Blue veins (at least in fair people) are now very distinctly seen, especially in the later months, and the origin of the nipple has often a moist appearance. Milk is very often present in the tubes, and may be squeezed from the nipple. Numerous cases of milk in the breasts, in single and not pregnant women, are on record; one of the earliest Baudelocque's ("Art d'Accouchement," tom. i. p. 188, 1822), was in a girl only eight years old—and the Authors themselves are acquainted with others, "L. H. Reports," vol. i. Authentic instances of milk in the male breast (not to be confounded with cystic disease) are also recorded by Humboldt and others. The first intimation received by the woman herself of this secretion, is probably a little moisture on the chemise, or under-garment. It frequently happens that true milk is not secreted in any quantity until after delivery, but at the fifth or sixth month we shall nearly always be able to distinguish the elements of that fluid by the aid of a $\frac{1}{4}$-inch objective, if the fluid from the nipples be placed on a glass slide. Dr. Lumley Earle has noted the occurrence of silvery streaks (like the lineæ albicantes to be described afterwards), which are seen by slightly stretching the skin of the breast between finger and thumb. These, of course, are best seen in multiparæ.*

IV. *Abdominal Symptoms.*—During the first two months or so, there is but little change in the size of the abdomen. Indeed, the French have a proverb, *En ventre plat, enfant il y a*, which has been quaintly translated by, "Before a bank there comes a lank," because at first the belly becomes flatter, and the navel sinks in. About the third month, however, the increased size of the abdomen becomes obvious, and from this time it goes on steadily growing bigger till nearly the end of gestation. About the fifth month, the uterus may be felt through the abdominal walls, and the navel has become shallower. At the sixth month the uterus reaches the umbilicus. At the seventh it is half-way between that and the ensiform cartilage. At the end of the eighth month it reaches the ensiform cartilage and the navel is very prominent, and between this and the end of pregnancy the uterus falls down again a little, so that the woman often seems a little smaller than at the eighth month. In typical cases, nothing can well be mistaken for this enlargement. When, however, the uterus is bi-cornate, or there is lateral displacement, so that the fœtus lies all on one side of the abdomen, when there is a very large quantity of liq. amnii, or when pregnancy is combined with ovarian disease, tumours, or even a very large quantity of abdominal fat, the diagnosis of pregnancy may often be very difficult. Numerous cases in Dewes, Montgomery, and other authors, and the well-known instance of Lady Flora Hastings, teach us how careful we should be not to make a diagnosis of pregnancy from the mere fact of enlargement of the abdomen. Our examination in such cases should be thorough, and if there be any doubt, we should seek further opinions, or wait for the arbitration of time. In general the tumour produced by the gravid uterus at the seventh month and afterwards, will be found symmetrical, ovoid, semi-solid, and dull on percussion. It will sensibly contract under the hand, especially if the latter be cold, and relax again, and Dr. Braxton Hicks has recently pointed out that the muscular sussurrus of the uterus may sometimes be mistaken for the fœtal heart. [*See* symptoms relating to the fœtus.] The outlines of the fœtus can often be plainly felt through the uterine wall, and a cold hand will often cause fœtal movements of a lively character. To support the increased weight of the gravid uterus, the woman walks more uprightly, with her head thrown back, and the toes turned out. Dr. Montgomery lays some stress upon a dark line extending from the naval to the pubes. This is almost invariably present, and is sometimes of considerable width. It may, however, date from a previous pregnancy—and something like it is sometimes seen in ovarian disease.

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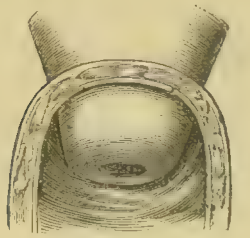
* During menstruation, in Ovarian disease, or by the mind being much directed to the subject, single and non-pregnant women may exhibit many of the Mammary symptoms described above—especially enlargement of the breasts. We can therefore scarcely be too cautious in forming our judgment upon this point, especially as really pregnant women occasionally show little change in the breasts until after delivery.

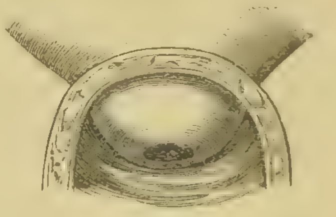
V. *Changes in the Uterus and Vagina.* The gradual enlargement of the uterus has just been described. From a weight of at most 2 to 3 oz. (unimpregnated) it gets to weigh some 24 oz. or even 2 lbs. But the changes in the cervix uteri (shown in figs. 72—75), are most important for us. The shortening of the cervix becomes evident about the fifth month, and at full term it can scarcely be said that there is any appreciable neck to the uterus. At the same time the follicles about

FIG. 72.



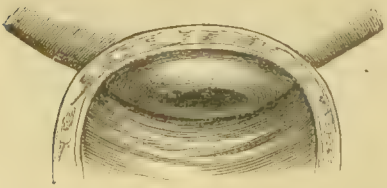
Os and CERVIX UTERI at 3rd month.

FIG. 73.



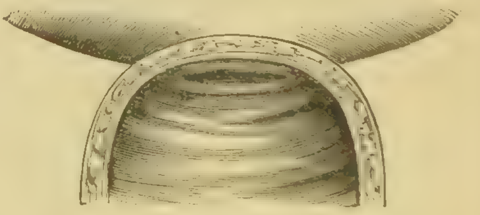
Os and CERVIX UTERI at 6th month.

FIG. 74.



Os and CERVIX UTERI at 8th month.

FIG. 75.



Os and CERVIX at the full term.

the os uteri become very perceptible. The os uteri is directed more backwards, and there is a peculiar velvety feel about it, well known to experienced obstetricians. It is filled with a plug of gelatinous mucus. The *uterine souffle* (*bruit placentaire* of some authors) can generally be heard after the fifth month (some have heard it earlier) either by auscultation over the uterus, through the abdominal walls, or by means of the metroscope. This souffle is a blowing sound, either hoarse and harsh, or soft, whistling, cooing, or musical. It is synchronous with the radial pulse. It is best heard near the usual site of placental attachment, and has therefore been ascribed to the placenta. It is, however, heard even after delivery for a few days, also in cases of fibroid tumours (without pregnancy), and is therefore of very slight diagnostic value. It is almost certainly an arterial bruit, but venous bruits also are heard over the gravid uterus. The vagina is generally somewhat relaxed, its artery pulsates more strongly [Osiander], and its mucous membrane is considerably congested, giving it a *violet tinge, shared by the inner surface of the vulva* (Jacquemin, Kluge, Parent Duchatelet). This being simply a pressure symptom, is of little value by itself. French surgeons attach considerable importance to a means of examination termed *Ballottement* or Repercussion, of which there are two kinds, external and internal. It can scarcely be applicable except between the fourth and sixth or seventh month. To practise internal ballottement, the woman must either stand upright, or lie with the trunk in a semi-recumbent position, to bring the uterus as low down as possible, and make its axis coincide with a line passing perpendicularly from the fundus uteri to the ground. One or two fingers of one hand must now be introduced into the vagina, and applied to that part of the os uteri which is most anterior. The other hand, or the hand of an assistant, should maintain steady pressure on the abdomen, and the patient should take in a long breath. Whilst she holds her breath, the fingers in the vagina must make a rapid jerking push against the uterus, and then, if the period of pregnancy be favourable, a hard body (the fœtus) will be felt to recede from, and fall back again on the tips of the fingers (rising and falling in the liquor amnii). External ballottement is a similar manœuvre, which is best done by having the woman on her side, with the abdomen projecting beyond the edge of the bed or couch. Whilst fully satisfied that this is a useful method of diagnosis in some cases, and fairly free from fallacies, the practical difficulties, and the limited period during which it is available, greatly detract from its value.

VI. *Symptoms due to the Fœtus. Quickening and Auscultation of the Fœtal Heart.*—Women in almost all ages, the older writers, even legal ones, have attached great importance to the first recognition, on the part of the mother, of fœtal movements, or, in other words, "quickening." The time of its occurrence is very variable; and living children have been born without the mother having perceived any movements at all. It generally occurs about the middle of pregnancy, from the sixteenth week to the twenty-fourth; but it may be postponed much later, or, as said above, be altogether wanting. As far as we are concerned, as medical jurists, it may be either a subjective, or an objective symptom. In other words, the patient may tell us of such movements, which may, however, be due to other causes, or we may feel them ourselves, through the abdominal parietes, in which case we must be careful not to mistake contractions (*a*) of the abdominal muscles, or (β) of the uterus itself, for the movements of the fœtus. Very active movements on the part of the infant in utero (S. Luke i. 41) can scarcely be mistaken for anything else. The sounds of the fœtal heart may sometimes be heard as early as the fifth month, and, supposing life to continue, may of course be heard up to the period of delivery. The spot at which the stethoscope should be placed so as best to hear the tic-tac of the fœtal heart, varies with the child's position in utero, &c. As a general rule, however, it may be said that the middle of a line drawn from the anterior superior spine of the ilium to the umbilicus on one side or the other is about the best spot. This valuable addition to our means of diagnosing pregnancy was discovered in 1818 by M. Mayor of Geneva. These beats of the fœtal heart vary in number from 120 to 160, 130—150 being most common, the number being greatest in females.

Dr. James Cumming ("Edinburgh Medical Journal," 1875, pp. 327—419), says, "for the same pulse-rate the male infant at birth should be heavier than the female, in the proportion of 20.2 to 19; or, if the female infant equal the male in weight, the female pulse will be the higher one." Frankenhauser ("Monatschrift für Geburts Kunde,") says, "that the fœtal heart of the male is slower than the female; and that pulsations under 144 may be taken to signify that a male infant is in utero."

They should not be synchronous with the mother's pulse. If we find them to be so, we have every reason to suspect that we have not heard the fœtal heart at all, but only the mother's apex-beats, conveyed through some solid or enlarged organ, such as the liver, or even by the walls of the abdomen. There are really two sounds of the fœtal heart; in other words, the number of sounds is from 240 to 320; but in counting, we reckon only the second, or loudest sound. The fœtal heart may cease to be heard for a time, even when the child is alive; and its total absence does not prove the absence of pregnancy, but makes it highly probable that the infant is dead, even when other signs of pregnancy exist. Sometimes a "souffle" is heard from the funis also. The so-called placental bruit has been already mentioned.

VII. *Miscellaneous Signs of Pregnancy. Kiestin, &c.*—Alterations of temper, and of character, strange antipathies, voracious or peculiar appetite (longings), an increased secretion of saliva, irritability of the bowels and bladder, and peculiar pigmented patches on the face, or arms (Dr. Swayne), anæmia of the optic discs and retinæ, causing transient amaurosis, headache (the so-called "test" of Beccaria was intense pulsating pain in the occipital region), tendencies to syncope and vertigo, convulsions, albuminuria or saccharine urine, very great increase of fibrin in the blood, hypertrophy of the heart (some degree of which is normal in pregnancy) giving rise to a stronger pulse than usual. All these have been noticed in pregnant women again and again; but none of them are diagnostic. So much, however, has been made of the so-called kiestin or gravidine, that some notice of it, though utterly worthless as a sign of pregnancy, seems called for. It was said, by its discoverer, that after the first month of pregnancy, the urine of the gravid woman, left to stand from thirty hours to eight days, gathers a pellicle, like "the fatty scum of cooled broth," and with a cheesy odour. This pellicle, when examined by tests and the microscope, shows fungi, triple phosphates, fat globules, and sometimes a peculiar form of albumen. Unfortunately men, young girls, and very old women may furnish urine of similar characters, so that it is no test of pregnancy. It is said, however, with great probability, that lime-salts (phosphates) are considerably diminished in the urine of pregnancy.

Note on Minor Signs.

Enlargement of the thyroid body, evidently known to Catullus [de Nuptiis Pelei et Thetidos, lines 376–7: "Non illam nutrix orienti luce revisens Hesterno collum poterit circumdare filo"] is another minor sign, less perhaps of pregnancy than of sexual excitement, as pointed out by Dr. James Reid. Another, very popular one, is known as "turning out the toes," alluding to the necessity for securing a wider basis, to support the increased weight of the gravid uterus. For the same reason the woman walks more upright, with the abdomen, as it were, pushed before her. It is also frequently noticed that she looks "ridiculously well." It is obvious, however, that these "signs" are of little forensic value.

Summary.

The extreme difficulty of diagnosing pregnancy in the earlier, and sometimes in the later months, shows plainly, as do numerous recorded cases, how morally criminal it is to intrust the determination of the state of a woman condemned to death to a jury of matrons without any special experience, and perhaps casually selected from the spectators of a trial!! In the vast majority of cases we cannot be certain of pregnancy till between the seventh and eighth months, however probable it may be.

The signs of pregnancy can scarcely be summed up better than in the words of Roederer ("Elem. Art. Obstetr.," p. 51):—

"Ex supra dictis sequentia corollaria eliciuntur:—

"Imum. *Ante 3tium mensem* certum graviditatis signum non facile datur. Probabilia tantum criteria sunt: orificii uterini descensus, ventris complanatio, menstruorum suppressio, tumor mammarum, symptomata a suppressionæ hac, vel a novo stimulo inducta.

"IIdum. *A 3tio ad 5tum mensem*, exploratio abdominalis recte instituitur. Ad quam si accedit suppressio menstruorum continua, successiva symptomatum morbosorum remissio, mammarum tumor crescens, lympha lacteis striis distincta, orificium uteri crassius, mollius, spongiosum, motus embryonis, &c., de graviditate, admodi certi esse possumus.

"IIIum. *Post 5tum mensem* status orificii uterini omnium minime fallit: precedentia recensita signa si continuantur et augentur, nullum plane graviditatis dubium est reliquum. Simul etiam cervicis tumor tunc tangitur.

"IVtum. *Sub initium, mediumque 7i mensis*, caput plerumque tactui offertur. Unam, duas, tres, quin quatuor ante partum, hebdomades, uteri ora inferior tenditur, aperturæ pelvis superiori apprimitur, et caput pone istam oram hærens pressioni in altum resistit."

Signs of Pregnancy in the Dead Body.

In the dead body of a pregnant female there might be several of the signs we have just described in the living, though of course the subjective phenomena, and those depending upon the circulation of the blood, would be absent. We should have (1)—The mammary changes; (2) After the third month we should have some of the abdominal signs, such as enlargement, feeling the body of the uterus through the abdominal walls, the pigment round the navel, and between it and the pubes. In the later months, when the uterine walls are thin, the outline of the fœtus can often be distinctly traced by palpation; (3) The changes in the neck of the womb, and the enlargement of its body, could also be easily recognised by examination per vaginam.

Supposing, however, that we make a post-mortem examination, and the woman has died with the uterus distended, we should have in addition (4) The presence of the fœtus in utero, with its placenta and membranes, after the second month; or, at an earlier date, only the ovum might be discoverable. A long description of the ovum at different periods of development would be out of place here; and we must refer for this to obstetric and physiological manuals. But some details and measurements will be given in the chapter on "Infant Viability" (*see also* pages 644—647); (5) In one or both ovaries a corpus luteum (or corpora lutea) will certainly be found. This name has been given to the peculiar cicatrix formed in the Graafian follicle when a ripened ovum has escaped from it, especially when that ovum has been impregnated; and although there have been many discussions as to true and false corpora lutea, this much appears to be certain:—

First, that "certain changes occur in the Graafian follicle, or ovisac at, or subsequent to, the time of ovulation. These changes are more marked when impregnation has occurred, than in cases of virgin ovulation, and result in the formation of the corpus luteum. At the time of the escape of the ovule, a clot of blood is effused into the cavity of the ovisac; and, according to the views of M. Pouchet, the epithelial lining, or membrana granulosa, undergoes a remarkable development. This membrane becomes thickened by a cell-formation, the hypertrophied layer being at first of a reddish colour, but afterwards becoming yellow (hence the name). The yellow matter is arranged in the form of plicæ, or folds, which diverge from the cavity towards the circumference of

FIG. 76.

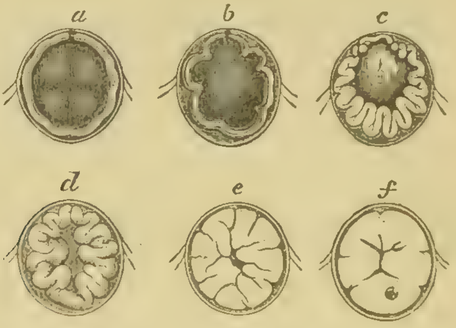
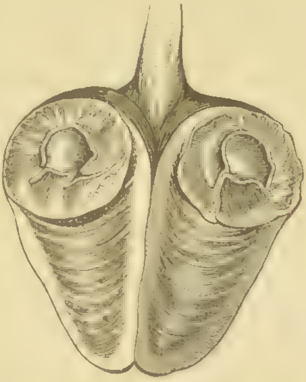


Diagram of FORMATION OF CORPUS LUTEUM IN A MAMMIFER.—*a.* Cavity filled with blood; *b*, *c*. Clot diminishing in size, while the epithelial lining becomes thickened and convoluted; *d*, *e*, *f*. Completion of the process. (From Dr. Tyler Smith.)

the ovisac. The new formation is gradually thrown into folds, or corrugations, by the contraction of the ovisac, and becoming thicker as the development of the corpus luteum proceeds, its internal surfaces are at length brought into contact. In this way the stellate cicatrix found in the centre of the true corpus luteum is formed. (Fig. 76, Tyler Smith.)

Before this apposition has occurred, the fibrinous clot has been decolorized, or converted into fluid, and in either case absorbed. The substance of the corpus luteum is soft, fleshy, and friable, and is permeated with numerous vessels from the external surface of the ovisac, so that the true corpus luteum admits of being injected from the vessels of the ovary. In size and shape, the true corpus luteum, that which follows upon impregnation (Fig. 77), resembles a small bean, and projects from the surface of the ovary as a mammillary body, occupying from one quarter to one-half of the entire superficies of the organ. It is largest in the early weeks of pregnancy; and after the third month it slowly decreases in size, until the time of parturition, when it rapidly retrogrades, and at length becomes a mere scar." (Tyler Smith.) "At the end of eight or nine weeks it has become so altered, that its colour is no longer distinguishable; and only faint traces of its convoluted structure are to be discovered by close examination. These traces, however, may remain for a long period afterward, more or less concealed in the ovarian tissue. We have distinguished them so late as nine and a half months after delivery." (Dalton.) The authors have frequently found them four to six months after delivery. In twin pregnancies we find, of course, two corpora lutea in the ovaries; but these are precisely similar to each other; and being evidently of the same date, will not give rise to any confusion. If two corpora lutea, of similar size, &c., are found with only one fœtus, one of them belongs to a blighted ovum. It is now quite certain that the mere presence of a corpus luteum is not in itself a sign of pregnancy; for a full explanation of which we must refer to "Dalton's Human Physiology," chap. vi., 5th edit., from which we extract the following table of the characters of false (or virgin) and true (or impregnated) corpora lutea. It will be seen from this table, that the latter differ from the unimpregnated, in not disappearing so quickly, by their further development, greater size, and yellower hue, as well as by their stellate structure. In a doubtful case we should distrust all very red bodies, and especially if we found several in different stages, inasmuch as pregnancy suspends the process of ovulation, and since, when more than one *

FIG. 77.



SECTION OF HUMAN OVARY, showing the Graafian Vesicle at 3rd month of gestation. (Dr. Tyler Smith.)

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* For further details on true and false corpora lutea, reference must be made to works on Obstetric Medicine. The subject is treated at some length in Ramsbotham's "Obstetric Medicine," Dr. Montgomery's work already quoted, and Cycloped. Pract. Med. "Pregnancy," p. 496; also "Edinburgh Monthly Journal," January, 1845, p. 58; do. vol. 53, p. 49; "Medical Gazette," Dec. 22, p. 43; ibid., vol. 35, p. 443; Taylor, *loc. cit.*

fœtus is formed, the corpora lutea formed at the same time are of nearly equal size, and of similar appearance :—

	Corpus Luteum of Menstruation.	Corpus Luteum of Pregnancy.
At the end of Three Weeks	Three-quarters of an inch in diameter, central clot reddish; convoluted wall pale.	
One Month .	Smaller; convoluted wall bright yellow; clot still reddish.	Larger; convoluted wall bright yellow; clot still reddish.
Two Months .	Reduced to the condition of an insignificant cicatrix.	7-8ths of an inch in diameter; convoluted wall bright yellow; clot perfectly decolorized.
Six Months .	Absent	Still as large as at end of second month; clot fibrinous; convoluted wall paler.
Nine Months .	Absent	One-half an inch in diameter; central clot converted into a radiating cicatrix; the external wall tolerably thick, and convoluted, but without any bright yellow colour.

The false, or, as it is better to term them, menstrual corpora lutea, seldom have a central cavity, and are generally smaller—and wanting the *stellate* cicatrix—they are also frequently multiple. Dr. Hicks has pointed out that abortion may dwindle the true corpus luteum of pregnancy. Dr. Knox's views on this subject are not accepted by practical obstetricians.

Period of Utero-gestation.

The duration of pregnancy in the human subject would seem, at first sight, to be an easy question to answer. It is a matter of common experience that a woman "goes with child," as the phrase is, for about nine calendar months, or ten lunar ones, a period of some 280 days. For ordinary purposes such a reckoning is sufficiently accurate, but both law and science ask us for more definite information, and we require to know not only the rule, but the exceptions. Several collateral issues are involved, such as the length of residence in utero required in order not merely that a child should be born alive, but that it should also be capable of living; and again, is it possible for this period of residence to be considerably protracted in certain cases, and if so, for how long? The question of infant viability will be dealt with separately, and for the present we shall confine ourselves to the duration of pregnancy.

Our courts of law usually consider forty weeks as the usual duration of pregnancy, and we believe rightly. Forty weeks equal 280 days, but nine calendar months may consist either of 273, 274, 275 or 276 days, in no case reaching the number of 280 days, or ten lunar months. Some of the older books on midwifery contain elaborate tables of the periods from one day of the year to another; the late Dr. Tyler Smith constructed an ingenious instrument, the Periodoscope, for the same purpose; but the simple table given below (from Mr. Seymour Haden's "Medical Visiting List") serves almost all practical purposes of reckoning.

Table for Calculating the Period of Utero-Gestation.

Nine Calendar Months.			Ten Lunar Months.		
From	To	Days.	From	To	Days.
Jan. 1	Sept. 30	273	Jan. 1	Oct. 7	280
Feb. 1	Oct. 31	273	Feb. 1	Nov. 7	280
Mar. 1	Nov. 30	275	Mar. 1	Dec. 5	280
April 1	Dec. 31	275	Apr. 1	Jan. 5	280
May 1	Jan. 31	276	May 1	Feb. 4	280
June 1	Feb. 28	273	June 1	Mar. 7	280
July 1	Mar. 31	274	July 1	Apr. 6	280
Aug. 1	Apr. 30	273	Aug. 1	May 7	280
Sept. 1	May 31	273	Sept. 1	June 7	280
Oct. 1	June 30	273	Oct. 1	July 7	280
Nov. 1	July 31	273	Nov. 1	Aug. 7	280
Dec. 1	Aug. 31	274	Dec. 1	Sept. 6	280

The above Obstetric "Ready Reckoner," consists of two columns, one of Calendar, the other of Lunar months, and may be read as follows:—A patient has ceased to menstruate on the 1st July—her confinement may be expected at soonest about the 31st March (*the end of nine Calendar months*); or at latest on the 6th April (*the end of ten Lunar months*). Another has ceased to menstruate on the 20th January—her confinement may be expected on the 30th September, plus twenty days —(*the end of nine Calendar months*) at soonest; or on the 7th October, plus twenty days (*the end of ten Lunar months* at latest).

Britton des Gardes (quoted by Montgomery) states that the old English code specified forty weeks as the limit of legitimacy. Our statute-books now, however, content themselves by referring to "the usual period of gestation," "the course of nature," "the laws of nature," and similar vague phrases. Nine calendar months or forty weeks being said to be the "usual" period—or "*legitimum tempus pariendi.*" Blackstone says ("Commentaries," vol. i., p. 456), "From what has been said, it appears that all children born before matrimony are bastards by our law; and so it is of all children born so long after the death of the husband, that by the *usual course of gestation* they could not be begotten by him. But this being a matter of some uncertainty, the law is not exact as to a few days." The consequence is that in this country, and in America also, whenever a question of legitimacy arises, the matter is made a subject of discussion, and skilled witnesses are examined at the time on this very question. One or two of these cases are so remarkable, that contrary to our usual practice we must briefly allude to them. Before doing so, we will, however, give the ordinary modes for computing the duration of labour, and the period at which birth should take place according to some of our best authorities.

Dr. Montgomery, quoting several classical authors—including Hippocrates and Herodotus—as well as the Apocrypha, finds that they all agree in the common reckoning of 280 days—even the passages which, at first sight, would seem to contradict this opinion, serve to confirm it when explained.

		FROM ANY DAY IN											
		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
TO ANY DAY IN	Jan. .	365	334	306	275	245	214	184	153	122	92	61	31
	Feb. .	31	365	337	306	276	245	215	184	153	123	92	62
	Mar. .	59	28	365	334	304	273	243	212	181	151	120	90
	Apr. .	90	59	31	365	335	304	274	243	212	182	151	121
	May .	120	89	61	30	365	334	304	273	242	212	181	151
	June .	151	120	92	61	31	365	335	304	273	243	212	182
	July .	181	150	122	91	61	30	365	334	303	273	242	212
	Aug. .	212	181	153	122	92	61	31	365	334	304	273	243
	Sept. .	243	212	184	153	123	92	62	31	365	335	304	274
	Oct. .	273	242	214	183	153	122	92	61	30	365	334	304
	Nov. .	304	273	245	214	184	153	123	92	61	31	365	335
	Dec. .	334	303	275	241	214	183	153	122	91	61	30	365

The illustrious Harvey, however, states ("Works," Syd. Soc. ed., p. 529) "unquestionably the ordinary term of utero-gestation is that which we believe was kept in the womb of his mother, by our Saviour Christ, of men the most perfect; counting, viz., from the festival of the Annunciation, in the month of March, to the day of the blessed Nativity, which we celebrate in December." This is a period of only 275 days. "Prudent matrons," he says, "calculating after this rule, as long as they note the day of the month in which the Catamenia usually appear, are rarely out of their reckoning; but after ten lunar months have elapsed, fall in labour, and reap the fruit of their womb, the very day on which the Catamenia would have appeared had impregnation not taken place." He states elsewhere, what is pretty generally believed by modern physiologists (loc. cit. p. 544), that "women are most prone to conceive either just before, or just subsequent to the menstrual flux." Dr. Wm. Hunter speaks of nine calendar months being the *usual* term. Sir James Simpson speaks of the normal duration as being "between 274 and 280 days." In Dr. Montgomery's table of thirteen cases dated from day of marriage, 10 or nearly 77 per cent., were in the thirty-ninth or fortieth weeks, but of twelve of them the average interval was 270⅓ days only. In Dr. Reid's twenty-five cases, dating from a single coïtus, 56 per cent. were in the fortieth week. In Dr. Montgomery's fifty-six cases, ten were in the thirty-ninth week (or 17·84 per cent., twenty-two in the fortieth week (or 39·28 per cent.), and nine in the forty-first week (or 16·07 per cent). Dr. Montgomery himself is very strong on 280 days being the *usual* period—although, as will be seen, his cases do not do more than render this probable. Dr. Matthews Duncan, who has given great attention to this subject, gives the following rule. Add 275 days to the day on which the Catamenia disappeared—then add three days more, and this 278th day will be the *day of delivery*." Or in common language, any nine calendar months added to the date of insemination + three days (or if February intervene, five days) will give the date of delivery, according to Dr. Duncan—or at least the *middle day of the fortnight*, during which delivery is almost sure to take place. Dr. Robert Barnes, whose authority in these matters is deservedly very high, states that 273 to 278 days is the most common period—275 being, he thinks, normal.* Naegele's method of calculating was somewhat peculiar. He added twelve calendar months to the time when menstruation ought to have occurred, and then deducted three months and eight days. Thus, supposing a woman ought to have been poorly on July 1st, 1874, add twelve months = July 1st, 1875. Deduct three months and eight days, and we get March 23rd, 1875, as the probable date of delivery = 266 days only—a period which we think too little. The Authors have collected eight cases in which the date of coïtus was fixed by remarkable circumstances, and find that all agreed in the 280th being the day of delivery. Dr. Tyler Smith sums up the result of his and others' experience thus : "In a practical point of view, we may consider that the average duration of pregnancy is about 280 days from the date of the last Catamenia, or about 274 or 275 days from the time of coïtus when this can be ascertained." So there is a pretty general consent amongst the best obstetricians as to the general duration of pregnancy—the extremes being from 266 days or thirty-eight weeks to 280 days or forty weeks. The question whether this period can be shortened is also sufficiently answered from common experience, seven months' children being sufficiently common. Dr. Montgomery mentions a case of a child born at 200 days (six months, eighteen days), who lived to be thirteen years old. Dr. Purdon mentions another born at six and a half months, who lived two years. Dr. Outrepont of Bamberg, speaks of one born at six calendar months, who lived, at all events, till he was eleven years of age. In the famous *Jardine* case, the parishioners of Kinghorn, in Scotland, brought an accusation of incontinency against the Rev. F. Jardine, who was married to his wife on March 3rd, 1835, and on the 24th August (five calendar months and twenty-one days, or 174 days after marriage), a daughter was born, who survived till the 20th March 1836. The enquiry lasted from 1835 to 1839, and in the end the ecclesiastical court (General Assembly of the Church of Scotland), pronounced the libel "not proven," thus deciding in favour of the legitimacy of the infant. The French law decides that children born after 180 days, or six calendar months, are legitimate and viable. The Scotch law allows six lunar months, or 168 days (less than Mr. Jardine's infant by six days) to be both viable and legitimate. An older case of a similar kind is reported, in which the Rev. Thomas Elder, minister of Whithorn, also in Scotland, was deprived of his clerical functions in consequence of a living infant having been born within five months after marriage (about the year 1710). This sentence was afterwards reversed, partly on account of his personal character, partly on account of a certificate signed by the celebrated Doctors Pitcairn, Preston, and Drummond, who declared "that a child born in the beginning of the sixth lunar month may be alive and continue in life, which is *consistent* with our observation and experience," Edinburgh, May 12, 1710. The Parliament of Paris in the case of Cardinal Richelieu decided "that the infant at five months possessed that capability of living to the ordinary period of human existence which the law of France required for establishing its title to inheritance." The Code Napoléon mentions 180 days, or six calendar months. Dr. Rodman of Paisley met with a case in 1815, in which a child survived for twenty-one months, whose mother believed she had carried it only nineteen weeks. But when twenty-one days old, the child measured thirteen inches, and weighed 1 lb. 13 oz. The mother, therefore, in all probability, made a mistake. Mr. Baber's case (of Buxer) reported in the "Calcutta Medical Times," vol. i. (1825), is probably one of the most authentic of early viability. The child was born at 6½ months, and after fifty days weighed only 1 lb. 13 oz. It was then fourteen inches long, the head measured 10 × 9·1 inches; and it is stated that it sucked freely. Dr. Barker (of Dumfries) reported a case in the "Med. Times and Gazette" (September 1850, p. 259—and October 12, p. 392), in which "a female child was born at the 158th day of gestation, or twenty-two weeks and four days (5½ months) after intercourse. She weighed 1 lb., and measured eleven inches—could not suck properly for a month, did not walk till nineteen months old; when 3½ years old, she was healthy, and thriving, although small."

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* In the celebrated Mordaunt divorce case, Dr. Spinks (counsel for the petitioner) appeared to take it for granted that from 274 to 280 days was the average period of pregnancy. There was an entry in Lady Mordaunt's diary of the 3rd of April against the 27th of June = 280 days ; and this was deemed an evidence of her guilt.

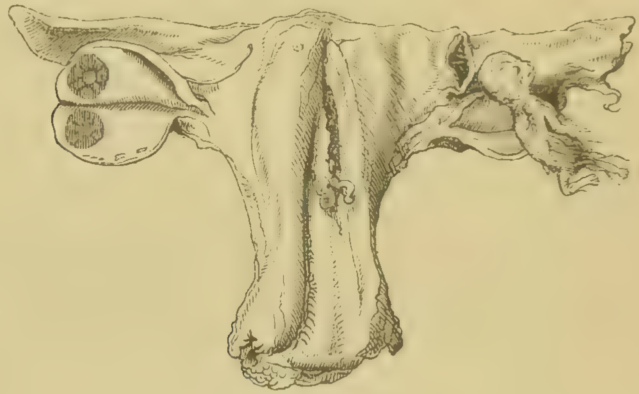
It must, therefore, be conceded, although such cases are rare, that children born very much *within* the ordinary limits of gestation may live. To guide our judgment in such cases, we may summarize the facts as follows:—(1) Such children will be much smaller, shorter, and lighter than those born at full term or near it. (2) Their general development, particularly as regards the cutaneous system (hair, skin, and nails), will be far behind normal infants (consult for this the table given at pp. 644 to 647 of the development of the fœtus). (3) They will require extreme care, both as regards the maintenance of bodily heat, and as regards nutrition.

Protracted Gestation.

Your opinion is far more likely to be asked on questions of protracted gestation. As a sample of such we quote briefly the chief facts of the celebrated *Gardner Peerage Case.* From reasons which are obvious, the children in such cases are usually posthumous, but sometimes, as in this instance, the husband and wife are separated from one another. Captain (afterwards Lord) Gardner, married Miss Adderley in 1796. They lived together as man and wife until January 30, 1802, on which day Mrs. Gardner parted from her husband on board ship. Shortly after he sailed to the West Indies; he returned to England on July 11. Before and during his absence, Mrs. Gardner carried on an adulterous liaison with Mr. Henry Jadis. On her husband's return, she was found with child, and expecting to be delivered in due time, she made no secret of this. The time passing, she professed to be, and was considered, dropsical. On the 8th of December, she was secretly delivered of a son, in the presence of three witnesses. The existence of this child was concealed from Captain Gardner, who only discovered his wife's adultery in 1803. They were divorced, and he married again in 1809. But in the year 1808 he succeeded to the title, and died in 1815, leaving a son by his second marriage, who in 1824 petitioned the king to be entered on the parliament roll as a minor peer. The son of the first and divorced wife, who claimed to be the eldest son of Lord Gardner, though he went by the name of Henry Fenton Jadis, and was born 312 days, or ten calendar months, and nine days after Captain Gardner left England as mentioned before, now opposed the claim of the son of the second wife, and claimed the peerage himself. The Committee of Privileges who conducted the enquiry, called before them sixteen of the most eminent obstetricians in London. Five of these maintained that the period of utero-gestation was a fixed one—from 270 to 280 days. (Drs. Gooch, R. Blegborough, Davis, Sir C. M. Clark, and Mr. Pennington) and discredited protracted gestation. Eleven (including Drs. Granville, Conquest, Blundell, Merriman, Power, Hopkins, Sabine, &c.) advocated the possibility of protracted gestation. Dr. Dewees, the late Professors Hamilton, M. Velpeau, Dr. Lee, Dr. W. F. Montgomery, the illustrious Harvey, Smellie, Dr. Ashwell, Dr. James Reid, Sir James Simpson, and other eminent names may be added as authorities on the same side of the question, although not in this particular case. This celebrated case was not decided on its own merits, at least as regards the protracted gestation, but on the grounds of the wife's adultery, and the concealment of the birth of the first child. [Dr. Taylor's large work on Medical Jurisprudence, and Dr. Montgomery's on the Signs and Symptoms of Pregnancy, contain fuller accounts of this trial—the medical evidence on it was published in extenso by Dr. Lyall, in 1827.] In a recent case (Renouf *v.* Eden, Queen's Bench, Feb., 1870, Drs. Tyler Smith and Robert Barnes, being asked as to the probable legitimacy of a child born 307 days (nearly 44 weeks) after the departure of the defendant, stated that they believed it to be highly improbable that the period should extend to 300 days, although they would not declare it impossible. Drs. Tanner and Clark deposed that they had known cases of 297 or 300 days, and that cases still more protracted were on record. Of these the most authentic (when proof is impossible) seem to us to be Dr. Reid's 293 days, Dr. Merriman's of 303 and 309, Dr. Blundell's 287, Dr. Beattie's 291, Mr. Skey's 293, Dr. Ashwell's 300, Dr. McIlvan's 293, Sir James Simpson's 300. Still longer periods are mentioned in American books! Most of these, however, really rest upon the testimony of the mothers, and are, therefore, not indisputable. The argument from analogy must undoubtedly have some weight. Thus M. Tessier found that in cows (whose natural period is 286 days, or very close to that of the human female) 20 out of 160 went 300 days, and 5 even as far as 308 days, whilst 50 went 270 to 280 days, and 68 from 280 to 290 days, the extremes were 67 days apart. He observed similar facts in mares, who go 300 days. Out of 102 mares, 21 went 360 to 377 days, and one as far as 394 days! The late Earl Spencer made observations on this point in 764 cows, the result of which was, that the average period was 284 or 285 days, whilst the longest period known was 313 days. Similar observations have been made in sheep, pigs, rabbits, and other domestic animals. We think the arguments on both sides may be summed up as follows:—

That it is quite certain that in both the human female and other mammals, the period of pregnancy may be slightly protracted: there is considerable evidence to show that cases have occasionally occurred in which 41, 42, or perhaps 43 weeks have elapsed since impregnation before the birth of the child, but that, whilst it is not impossible that even 44 weeks (308 days), or even longer periods of gestation might occur, there are no *certain* instances of such on record. It is a self-evident matter that moral considerations, such as those of character, and the circumstances of the case and its surroundings, as regards the probability or possibility of sexual access, are matters for the court rather than for the medical witnesses. We should naturally expect over-mature infants to be of uncommon weight and length, and it has been so in some of the most credible cases. You must not forget, that in extra-uterine fœtation,* life has been prolonged over nine months in some cases, and a dead fœtus has been carried in one such case even as long as forty-three years ("Obstetrical Society's Transactions," vol. viii. p. 106). Another case in which a pregnancy lasted thirty-one years,

Fig. 78.



Tubal Pregnancy, with the Corpus Luteum in Ovary of opposite side.

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* In doubtful cases of suspected pregnancy in the dead body, we must remember that an ovum may undergo more or less complete development *out* of the uterus altogether, in one or more of the following situations: (1) In the ovary itself: (2) in the Fallopian tube, *see* fig. 78; (3) in the walls of the uterus; (4) in the peritoneal cavity. A favourite situation being the pouch of Douglass, in which case, however, as in the three former, the pregnancy can hardly proceed farther than the first half of the usual period, if so far, without either perishing or leading to the death of the mother. In the general cavity (abdominal pregnancy) the ovum may, however, go on to its full development, and, if not excised, become encysted, and even remain dormant forty years!

and a full-grown male infant in a state of partial calcification was removed post-mortem, is recorded by Dr. Housset in his "Observations Historiques sur quelques écarts oujeux de la Nature, &c.," Neuchatel, 1785, pp. 26—73.*

Signs of Recent Delivery and of Previous Gestation, in the Dead and in the Living.

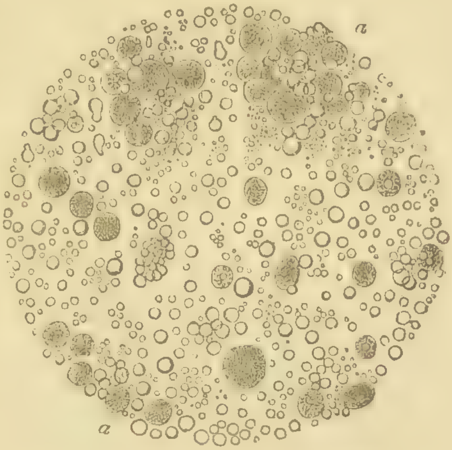
You may be asked in cases of suspected child-murder and concealment of birth—Has this woman been *recently* delivered? To settle this question you must of course examine the woman (Cautions, p. 688). The certainty with which you can answer this question will greatly depend upon the time which has elapsed *since* the birth of the child. If you see her *within a week*, most of the following symptoms will be present:—

1. The pulse, in all probability, will be a little quickened, and at all events soft and compressible (pulse of Asthenia).

2. There is generally a peculiar expression of countenance, and a peculiar odour about the body well known to all who are practical obstetricians. There is often a dark areola under and around the eyes.

3. The breasts will almost always contain milk, they show the areola, pigmentation and follicles described under pregnancy, they are turgid, tender, and knotty, and the nipples are more than usually prominent [there are exceptions to this state of nipples]. The first milk or colostrum is yellower, richer in salts, and of higher specific gravity than later milk, being as 1072 to 1032, and contains an enormous number of granular corpuscles (like so called exudation corpuscles). With reference to the silvery streaks on the breasts, whilst we believe them to indicate *pregnancy*, or at all events, a previous *distension*, we cannot admit that they indicate recent delivery.

FIG. 79.



FIRST MILK, WITH COLOSTRUM CORPUSCLES.

4. The skin is usually moist, soft, and relaxed. On the abdomen in particular, it is quite flaccid or flabby, and even thrown into folds in many women; and numerous shiny streaks (lineæ albicantes †) or cica-

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* In discussing protracted gestation, distinction between "insemination," or the sowing the seed, and "impregnation" or fertilisation of the ovum should be mentioned. It is probable that the semen or spermatozoa may be quiet in the cervix uteri, or uterus some time before the concourse of the male and female atoms is effected; and thus some days from coitus must be accounted for.—Dr. Barnes.

† On the subject of the *lineæ albicantes* or cicatrices of the abdomen, thighs, &c., see Schroeder's "Lehrbuch der Geburtshülfe," Bonn, 1872, and the translation by Dr. Carter—"A Manual of Midwifery, &c.," London, 1873. He states that they are present in the great majority of those pregnant. (Credé says they are absent in 10 per cent., Hecker in 6 per cent.) He considers them as by no means diagnostic of

trices may be seen there and on the thighs, the dark line around the navel, and from that to the pubes will be seen as in pregnancy, sometimes the muscles are separated in the median line. On passing the hand downwards and pressing firmly over the lower or pubic region we can feel (5) the enlargement of the uterus, which is often as large as the head of a new-born child for some three or four days, and as large as a cricket ball for a considerable time after pregnancy. In health the complete involution of the uterus takes from fourteen to twenty-eight days. In some cases (sub-involution) many weeks or months are required for this process. You will often find the womb rather on one side.

6. By a vaginal examination, we feel the os uteri to be gaping. We may be able to pass two or three fingers into it with ease, and its margins will be found fissured or torn, especially if the speculum be used. By the uterine sound we can ascertain the increased depth of the cavity, and also that the tumour felt *ab extra* is really the uterus. We may also find exuding from it—

7. The lochia, at first coloured like blood, then nearly colourless, brown or green (the green waters). After a week this sign may be absent, and sometimes they are suppressed.

8. The perinæum will in all probability exhibit more or less of recent laceration, and the vagina and uterus, as far as seen, will have a dark, almost bruised appearance.

We must insist upon the necessity of a *combination* of these signs, as in the case of pregnancy, for many of them may be produced by disease or accident. Even one of the most important, the increased depth of the uterine cavity, might, for instance, be produced by retained catamenial fluid in a virgin, or by hydatids of the uterus, or by hypertrophic elongation of the cervix.

Signs of Recent Delivery in the Dead Body.

The condition of the breasts, abdomen, uterus, and vagina just mentioned would all be present, but we should have in addition a *corpus luteum,* in one or both ovaries. We should be better able to satisfy ourselves of the condition of the uterus, which would within a week present a deep, dark, almost black, and bruised appearance, all over its interior ; scarcely anything like a true mucous membrane could be made out, the sinuses would be found very large, admitting a goose-quill or even a finger easily ; and the weight of the organ (apart from all fibroid or adventitious growths) would be found to be very nearly sixteen ounces.

Dr. Montgomery (a high authority on these subjects) says, "Should death take place during or immediately after the act of parturition, especially from hæmorrhage, the uterus may be found lying

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pregnancy—only of previous distention. Schultze found them on the thighs of 36 per cent. of women who had never had children, and in 6 per cent. of men. He thinks the difference explicable by the greater development of the hips at puberty in the female sex. Schroeder refers to the three authors quoted : viz. Credé, Hecker, and Schultze, *loc. cit.* p. 65, note. When, however, there is no history of ascites, ovarian dropsy, or other unusual distention of the abdomen, &c., the authors still believe that pregnancy at some previous period may fairly be inferred, provided other appearances do not counter-indicate this.

in the abdomen, a flattened flabby bag, from eight to ten inches long, its mouth gaping wide, so that the hand would pass through it without resistance; its parietes are soft and relaxed, its cavity often containing large coagula of blood, and its internal surface covered with the soft and pulpy remains of the decidua, intermixed with flakes of lymph, which, if the part be immersed in fluid, appear as flocculent processes, adhering to and springing from it in great numbers; while the portion to which the placenta had been adhering, usually about a third of the inner surface of the contracted organ, is distinguished by having less of these deciduous flakes; the substance of the organ, in that situation, appearing as if laid bare, and exhibiting several semilunar, and apparently valvular openings in its structure." "But these changes will be greatly altered should the woman have survived delivery a few days . . . . . So that in some instances the womb may be found as large at the end of a week [and even after two or three months in some cases of sub-involution. Eds.] as in others where the examination is made within two or three days. It would, therefore, be very difficult, if not impossible, to assign the exact dimensions which the uterus will present at given periods after mature delivery; and should it have occurred prematurely, these dimensions will, of course, be thereby still further affected. When delivery has taken place at full time, and the uterus has contracted perfectly, if an examination be made within a day or two, it will be found about seven or eight inches long, and four broad; its external surface having a vascular appearance, and not unfrequently presenting patches of a purplish colour; its substance, divided by the knife, is found from one to $1\frac{1}{2}$ inches thick, of the consistency and nearly of the colour of firm muscular fibre, of which it appears to consist, and the cut surface displays the orifices of a great number of very large vessels: it now weighs about a pound and a half. In the writer's museum is the uterus of a woman who died on the second day after delivery, at the full time, and it measures 8 inches in length by $4\frac{3}{4}$ in breadth, and 3 inches in the antero-posterior diameter. Its parietes are $1\frac{5}{12}$ to 1 inch in thickness." "At the end of a week the organ has diminished to between five and six inches in length, and weighs about $1\frac{1}{4}$ lb.; after a fortnight it does not exceed five inches in length, and its weight is reduced to about three-quarters of a pound, or a little less; its vascularity is diminished, and the thickness of its parietes is reduced about one-third; their density is, however, increased in a like proportion, so that the orifices of the vessels are much less distinct, and the colour of the muscular substance has become much paler. But it must ever be taken into account that the dimensions of the uterine tumour, after delivery, will depend, first, on the activity of the contraction and absorption which takes place; secondly, on the interval of time elapsed; and thirdly, on the period of gestation at which its contents were expelled; so that, for example, if delivery occurred in the sixth month, the uterus would be found as small two or three days after delivery as it would at the end of two or three weeks after parturition at the full time." Dr. Montgomery gives several cases in illustration.

Authority.	Date of Death after Delivery.	Period of Gestation.	Length in Inches.	Breadth in Inches.	Antero-posterior measure in inches.	Thickness of Walls.	Weight of Uterus.
						Inches.	
Dr. Montgomery	2 or 3 days.	Full term.	7—8	4	—	1—1½	$1\frac{1}{3}$lb.
Do. . .	2 days.	Do.	8	4¾	3	$1\frac{6}{12}$—1	Do.
Do. . .	7 ,,	Do.	5–6	Not given	Not given	Not given	1½lb.
Do. . .	14 ,,	Do.	5	Do.	Do.	¾ to 1	¾lb.
Do. . .	16 ,,	Do.	$5\frac{2}{12}$	$3\frac{5}{12}$	Do.	7—8 lines.	Not given
Do. . .	13 ,,	7th month.	$3\frac{9}{12}$	$2\frac{9}{12}$	Do.	6—7 ,,	Do.
Do. . .	8 ,,	3½ months.	5⅛	3⅝	2¼	6—8 ,,	Do.
Do. . .	A few hours.	5 months.	5⅝	3¾	1½	7—9 ,,	Do.
Do. . .	4th day after twins.	End of 6th month	7	4½	2	¾ inch.	N.B. Only one *corpus luteum.*
Do. and Prof. Geoghegan .	14 days.	5 months.	4½	2¾	1⅛	Posterior wall very thick, double that of anterior.	Not given.
Do. and Prof. Banks . .	4th day after twins.	5 months.	4½	3	2	—	—

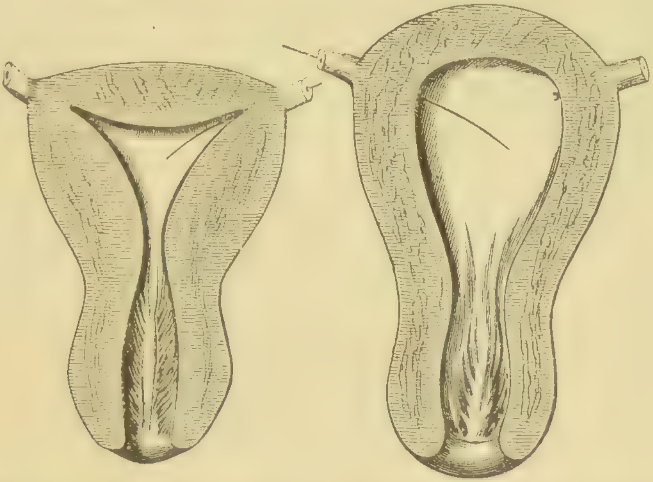
In addition to the weights above given, the following may be quoted :—

Authority.	Date of death after delivery.	Weight of Uterus.
Dr. R. Heschl . .	Immediately after delivery .	1lb. 6—8oz.
Do. . .	Do. in twin cases . . .	2lbs. 5—7oz.
Do. . .	7 days	1lb. 3—5oz.
Do. . .	14 days	10 to 11oz.
Do. . .	5 weeks	5—6oz.
Do. . .	2 months	1½ to 2½oz.
Dr. Tyler Smith .	Just after delivery . . .	1½lb.

"Has this woman ever had a child or no? or ever been pregnant?" A husband who suspects his wife's chastity or fidelity either before marriage or during long absence from home—a lady whose character is assailed—may both put this question to you. It is an important matter in some cases of disputed identity. It was raised in the trial of *Wainwright* for the murder of *Harriet Lane*, and in this instance the uterus itself was the chief topic of discussion and the chief witness. Let us remark in *limine*, that the presence of a hymen is proof positive that no mature or nearly mature infant has been born per vias naturales. *Cæsarian section* would leave a long cicatrix. Extra-uterine fœtation might indeed exist, but great caution should be used in deciding on the nature of the contents of cysts, since hairs (of the character of fœtal hairs), teeth, and bones may all be found in Ovarian and other dermoid cysts, and even in the *male*. They are often remains of an original twin pregnancy of which the subject of the tumour is the surviving twin. Again, if the loci, or breasts, or other parts of generation preserve their elasticity and virginal character [*see* Rape], the presumption must be strong against previous pregnancy. Cicatrices (such as lineæ albicantes) may be caused by Ovarian tumours and ascites. The breasts may have been changed by manipulations, and a relaxed or torn condition of the genitals *may* have been produced by disease or accidents.

When we come to the uterus itself, the matter appears easy of decision if we trust the text-books. Thus the general figure and characters of the nulliparous and multiparous uterus are well shown in the figs. below, from Dr. Tyler Smith (pp. 37 and 38 of his Manual of Obstetrics).

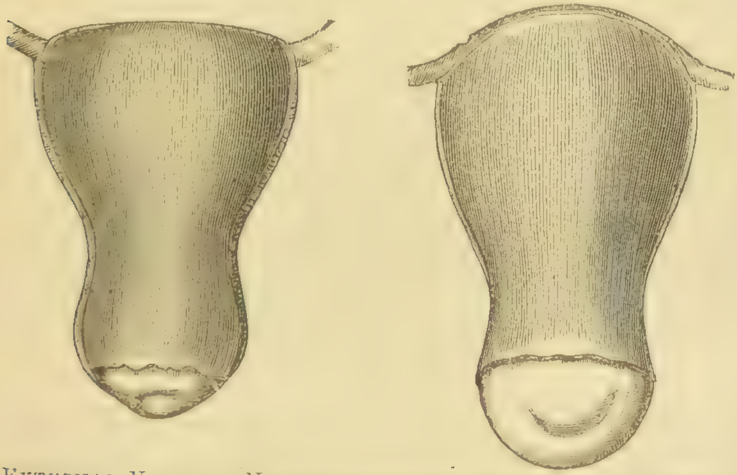
FIG. 80. FIG. 81.



SECTION OF THE NULLIPAROUS AND MULTIPAROUS UTERUS.

Dr. Tyler Smith remarks that "the term nulliparous uterus is evidently to be preferred to that of virgin uterus, as intercourse without impregnation exerts no influence upon the anatomical characters of the organ. In the multiparous uterus the anterior and posterior surface of the body is more rounded. The fundus instead of being flat is convex, so that there is a considerable protuberance above a line drawn from tube to tube. The vaginal portion of the neck is altered, being usually larger and more prominent in the vagina. The os uteri instead of presenting a transverse fissure or smooth round aperture is more oval or puckered in shape. The

FIG. 82. FIG. 83.



EXTERNAL VIEWS OF NULLIPAROUS AND MULTIPAROUS UTERUS.

depression felt by the finger is more evident, and the orifice is considerably larger. These changes in the os uteri are most evident in women who have borne large families. They are imitated to a slight extent in nulliparous women who have been subject to inflammatory conditions of the os uteri, to dysmenorrhœa, polypus, or any of the conditions which excite the growth of the organ; and by surgical operations. The uterus which has been fully developed by gestation rarely returns to the size of the nulliparous organ. Exceptionally, the uterus after delivery undergoes premature atrophy, analogous to the normal senile atrophy which commonly takes place after the climacteric. Meckel gave the weight of the nulliparous organ at seven or eight drams, and the multiparous at an ounce and a half. [These are, perhaps, a little under the mark. *Authors.*] The diameters are all increased in the multiparous organ. The *interior* of the uterus also offers some remarkable differences in the two organs. The cavity of the body of the multiparous womb is considerably enlarged. The os uteri internum is less distinct, and the canal of the cervix is shorter, the penniform rugæ being to some extent obliterated. The cavity of the body becomes distinct, less distinctly triangular in shape, the angles into which the Fallopian tubes enter being less marked. These changes are not without practical importance. Their consequence is obvious in a medico-legal point of view. A few years ago a lady of family and her maid were burnt to death together in an hotel at the West End. The bodies were so mutilated as to render any recognition by external signs impossible; but the lady had borne a numerous family, and the identity of her body was ascertained from the condition of the uterus." Two conditions, known to obstetricians as hyper and sub-*involution* of the uterus may, however, greatly affect these appearances. Like the heart and other muscles, the walls of the uterus may be found either thicker or thinner after much exertion.*

Beck (*loc. cit.* p. 161) gives the following measurements from Velpeau and Madame Boivin.

	Nulliparous Uterus.	Multiparous Uterus.
Total length	26 to 28 lines.	2½ to 3 inches. =30 to 36 lines.
Length of neck	13 lines.	13 to 15 lines.
Length of body	13 lines.	2 inches.
Thickness of uterine walls . .	5 lines.	6 lines.
Cervical walls	2 to 4 lines.	8 to 10 lines.
Breadth of neck	9½ lines.	18 lines.
Thickness of neck	7 lines.	8 to 10 lines.
Total weight without appendages .	4·9 drams (Boivin). 8 to 12 drams (Velpeau).	1½ to 2 ounces.

Chaussier and Brookes noticed a peculiar thinning of the centre of the osseous plates of the bones of the ilium as an indication of having borne children [*see* Beck, *loc. cit.*]. The nerves of the uterus and its appendages also become larger during gestation [Tiedemann, Chaussier, Wm. Hunter, Robert Lee, &c.].

There can be no doubt of the general truth of these observations on the differences between the uteri of women who have borne children, and those who have not. By the touch, specula, and sounds, some of these differences can be appreciated in life. Our real difficulties arise in the exceptional cases, or where some years have elapsed since the delivery, or there has, perhaps, been but one child, or the children are prematurely born.

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* The work of the uterus and other muscles in labour is reckoned by different authors at from fifty-four pounds to a quarter of a ton! There is no doubt it is often enormous.

Dr. Barnes gives the following measurements in his "Diseases of Women" [page 32], on the authority of M. Richet.

	In the Virgin.	In Women.	In Mothers.
	Inches.	Inches.	Inches.
The vertical diameter of the uterus . . .	2·20	2·52	2·72
Vertical diameter of the cavity . . .	1·80	2·20	2·44
Transverse diameter of the uterus . . .	1·24	1·80	1·90
Transverse diameter of the cavity. . .	0·60	1·08	1·24

MM. Guyon, Richet, and Barnes, point out that the uterus attains its maximum during the menstrual periods, and its minimum during the intervals, so that just before and just after the periods, the mean diameters will be a little exceeded, in the intervals they may be a little below the means. The vertical diameter of the uterus is unequally divided between the body and the neck. In the virgin the longest portion belongs to the neck. In multiparous women the two diameters are nearly equal; the difference, if any, inclining in favour of the body. In multiparæ the body continues to grow, whilst the neck has undergone an absolute or comparative shortening, which reduces its vertical diameter in some cases below that of the body. The *arbor vitæ* of the uterus is commonly much smoothed down after the first labour. But this is not constant, and it is sometimes found intact after several labours. The following weights and measurements are also taken from Dr. Barnes (*loc. cit.*). The weight of the uterus in girls at the age of puberty is from 360 to 1000 grains; from 1,200 to 1,800 grains in women who have borne children. It may be reduced to 100 or 200 grains in old women. At the term of gestation it may weigh from 26 to 52 ounces.

The normal length or projection of the os tincæ or vaginal portion of the uterus is 0·25 to 0·5 inch. The *isthmus* or os internum is generally 0·20 inch to 0·25 inch long, 0·16 inch across, and 0·12 from before backwards in imparous women. In multiparæ the length of the isthmus, which is always included in the measurement of the body, is reduced to 0.16 inch, and even less. The *walls of the uterine cavity*, apart from pregnancy, are 0·40 to 0·60 inch thick. The thickness is greater in women who have borne children than in the virgin.

CHAPTER XXIV.

MALAPRAXIS, OR MALPRAXIS.

Unprofessional conduct—Fractures—Dislocations—Obstetric cases—Medico-legal bearings of syphilis.

The charge of mal-practice, or in other words, of improper treatment of a case, may be made against yourselves, or other legally qualified medical men, against a midwife or nurse, against medical students, or assistants, or chemists, and others having partial knowledge of medicine and surgery, as well as against quacks and persons totally ignorant of medical science, practising from real or assumed motives of benevolence. Considerable misapprehension of the actual state of the law, as administered, exists in the minds of many medical men and others on the subject of unqualified practice. It is often thought that any person practising physic, surgery, or obstetrics without a legal qualification or diploma, incurs thereby the penalties of the law. This is by no means strictly true. On the contrary, as the law is administered, such a person, should he have the misfortune to kill or permanently injure anybody, usually fares somewhat better than a legally qualified practitioner would. The law, as it exists in our statute books, may be briefly stated thus :—

"Registration is not compulsory upon medical men, nor can any penalties be inflicted upon an unregistered person, who, having obtained a qualification in medicine or surgery, practises according to such qualification. No unregistered person, however, can recover any charge, in any court of law, for any medical or surgical advice or attendance, or for the performance of any operation, or for any medicine which he has both prescribed and supplied, whether he be qualified or unqualified. Neither may any unregistered person hold any appointment either as a physician, surgeon, or other medical officer, either in the military or naval service, or in emigrant or other vessels, or in any public institution not supported wholly by voluntary contributions (this includes asylums, parochial appointments, friendly societies, and public health offices). No certificate signed by an unregistered practitioner is valid. A qualified but unregistered practitioner may, therefore, keep an open surgery, and do a ready-money business, but he is debarred from recovering any fees or charges, and may be proceeded against for penalties by any of the medical or surgical corporations whose jurisdiction he may infringe by not having obtained the necessary diploma or licence. These rights have, however, rarely been exercised of late years, except sometimes by the Society of Apothecaries. A penalty of £20 may be inflicted for every such offence for practising as an apothecary in England or Wales, without the licence of the Society, and a penalty of £5 for every such offence upon any person acting as assistant to an apothecary to compound and dispense medicines without having obtained the certificate of the Society. The Pharmaceutical Act does, however, cover a great deal of irregular practice. But the Apothecaries' Society can afford no protection against bone-setters, unqualified midwives, and the like. Any person who *wilfully and falsely pretends* to be, or takes or uses the name or title of a physician, doctor of medicine, licentiate in medicine and surgery, bachelor of medicine, surgeon general practitioner, or apothecary, or any name, title, or description implying that he is a registered person, or that he is recognised by law in any of these capacities, may, upon a summary conviction, be fined a sum not exceeding £20. Convictions are, however, not easily obtained." (This paragraph, with slight abbreviations, is taken from an abstract, prefixed to the "Medical Directory," by R. G. Glen, Esq., LL.B.).

Unprofessional Conduct, or "Conduct Infamous in a Professional Respect."

The General Medical Council have the power of removing from the "Register" any medical practitioner "who shall be convicted in England or Ireland of any felony or misdemeanor, or in Scotland of any crime or offence, or shall after due inquiry be judged by *the General Council* to have been guilty of infamous conduct in any professional respect."

The spirit of our law, as laid down by the judges on repeated occasions, is that a medical man, acting in any professional capacity, is not bound and does not undertake to use the highest possible degree of skill, nor does he guarantee a cure, but "he undertakes to bring a fair, reasonable, and competent degree of skill." And if it can be shown that he has exhibited a "culpable want of attention and care, or the absence of a competent degree of skill and knowledge," and that injury is caused to his patient thereby, he is *liable to a civil action for damages even if he gives his services*, unless it can be shown that the patient contributed to such injury by his own negligence or carelessness. "A medical man who exhibits *gross* negligence, or evinces a *gross* want of knowledge of his profession, is *criminally* responsible for the consequences, but he is not liable to a criminal investigation for every slip." It must be a substantial thing. In the eye of the law gross neglect amounts to felony.

The majority of our judges are inclined to make every allowance for the difficulties imposed by the responsible duties of medical men. It must be confessed, however, that both at their hands, and more particularly at the hands of juries, the most arrant quacks, whose practice was little better than a long series of murders, have often met with more protection when arraigned on criminal charges than registered practitioners. A part of this must be ascribed to the love of liberty and free trade natural to Englishmen, and part to a very natural and just idea that superior knowledge ought to protect a man from making gross mistakes.

It is obviously impossible in an elementary work to deal with more than a minute fraction of the cases likely to come under the heading of malapraxis.

The following are, however, the chief varieties of such charges, and their most likely occasions:—

I. You or others may be charged with malapraxis in cases of injuries to bones or joints, real or alleged fractures and dislocations, and the results of accidents.

II. You will find such charges not unfrequently arising out of midwifery cases. (The charge of attempting to produce abortion is more serious. *See* the chapter on that subject.)

III. A doctor, nurse, or midwife, may be charged with communicating syphilis.

IV. You or others may be charged with not attending a patient sufficiently often, or sufficiently long, in a chronic malady.

V. Erysipelas, or untoward results of operations, may be ascribed to your fault.

Ununited Fractures.

The following are the *average* periods at which simple fractures of the long bones unite with tolerable firmness; but there are numerous exceptions:—

Thigh-bone usually unites in . . .	5, 6, or 8 weeks.
Leg bones „ „ „ . . .	4, 5, or 6 „
Bones of the arm or forearm . . .	2, 3, or 4 „

What are called *compound* fractures, that is, when there is a wound or wounds leading down to the broken bone, and fractures complicated with injury of soft parts, although not compound, may be far more tedious, even if recovery takes place.

A *comminuted* fracture (one when the bone is very much broken) need not necessarily take longer in uniting, but such accidents will almost necessarily be severe. There are some cases where the food or the blood, or perhaps both, are wanting in calcareous salts, and in these the bones do not unite, or only after very long periods. Certain diseases (as rickets, mollities ossium, cancer, sea-scurvy, tubercle) and pregnancy have been said to retard bony union. Our own experience is opposed to this, except in the case of sea-scurvy. The great cause of non-union of fractures is, as stated by Mr. Syme, a want of accurate adaptation of parts, and too great mobility or play being allowed to the fragments; absolute immobility being the desideratum in these cases. The movement of the broken bones may not, however, be the surgeon's or the nurse's fault. It frequently occurs at sea from the tossing of the vessel; on shore from the restlessness and unmanageability of the patients. In other cases, delay or failure in union may be due to some of the soft parts getting between the fractured ends, or to the blood-vessels being much damaged at the time of the original injury. The position of the nutrient artery in relation to the seat of fracture has much to do with the time taken in repair. Surgeons are sometimes blamed for not "setting" a fracture directly they are called to it. Provided, however, that care be taken to put the limb in an easy position (say on a pillow), and to prevent further injury, no harm is done, in a simple fracture, by waiting a few hours before putting it up in splints or other apparatus. No bony matter, even of a provisional kind (so called "provisional callus"), is thrown out for a period of three to six days after the fracture.

Some bones (the patella, olecranon, and neck of the thigh bone) usually unite by ligamentous union, that is, by firm fibrous tissue, instead of bone. Provided the splints, or other apparatus used instead of them (as plaster-of-paris bandages, paraffin bandages, leather, pasteboard, hooks and screws, as in Malgaigne's apparatus for fractured patella, double inclined plane, pillows and straps, the "jacks," pulleys with weights, and the like), keep the limbs in good position, and the fractured ends or portions of bone in close proximity to each other, very great diversity of appliances may be used by different surgeons with equal success.

Great care should, of course, be taken to prevent bed-sores, or sores forming on the heel, malleoli, and other prominent parts. But no amount of care will always succeed in very debilitated and cachectic subjects.

It is not possible to say how often a surgeon should see a case of fracture, whether simple or compound, so much must depend upon the circumstances of each case. But except in severe cases, or compound fractures with profuse discharge, a daily visit will seldom be necessary after the first week. By some methods (plaster-of-paris bandages for instance, or Malgaigne's hooks) no further active treatment may be needed after the first setting. More often, re-adjustment of the splints or bandages will be necessary after a few days, when the swelling caused by the injury has subsided. In almost every case, a nurse or attendant should be made responsible for a frequent inspection of the limb, to see that it is in a good position. This is especially necessary in fractures of the lower extremities.

It is sometimes necessary to *remove* portions of bone, which overlap too much. An accurate knowledge of muscles will often prevent the necessity of this. Compound fractures may often be converted into simple ones, by careful closure of the wound, and exclusion of air, by Lister's and other antiseptic methods. For details on these points, we must refer to surgical works. It is, however, necessary to remind non-medical readers that both the difficulties and dangers of the case are immensely increased by the smallest opening communicating with the bone on the one hand, and with the air on the other. These dangers are still more aggravated when large joints, such as those of the knee, or hip, are opened into, or implicated in the original mischief. Such accidents are often rapidly fatal, sometimes almost mysteriously so.

Dislocations.

In general, dislocations require nearly as long a period as fractures, or even longer, for the ligaments to unite firmly. Most dislocations are reduced with comparative ease when recent. If not reduced quickly, gangrene may result from pressure on the main arteries supplying the limbs.

Some dislocations (as those of the thigh, and thumb, and astragalus) are difficult to reduce. When arterial degeneration is present, the force used to reduce the dislocation may be sufficient to rupture the artery. This has sometimes happened in old people to skilful operators. It is scarcely necessary to state that if the foot is used to press against either axilla or perinæum to reduce a dislocation, the boot should be removed. This has sometimes been forgotten. The clove-hitch should be used in the towels, &c., used to make extension. Before attempting to reduce a dislocation, the surgeon should ascertain that an accident, and not disease, is the cause.

It can only rarely happen that any good can be done to very old dislocations. Still, under certain circumstances, it may be right to attempt the cure of dislocations of several weeks, or even a few months' standing. Successful cases of this kind may be found in the medical journals, and some at as long a period as six months are known to the Authors. As a general rule, it may be said that compound dislocations are equally, if not more dangerous than compound fractures, from the exposure of joints to septic and decomposing matters. Mixed cases, *i.e.*, fractures combined with dislocations, are of course more difficult and dangerous than simple cases of either kind. The Authors find it impossible to lay down any general rules guiding the conduct of the surgeon in the treatment of fractures, or dislocations, or mixed cases, except such as may be found in any standard work on surgery (such as Erichsen's, Bryant's, Holme's, or Druitt's Manuals).

Two cautions may, however, save much subsequent annoyance. The *first caution* is to make the first examination of such cases as thorough as possible. Do not overlook a dislocation of the shoulder or hip because you have discovered a fracture of the forearm or leg! Every articulation and bone should, so to speak, be interrogated, that is, examined, under anæsthetics if necessary. Of course some cases may present too much shock, or exhaustion, to permit such examination at first, but if the patient live, it should be made as early as possible, because swelling of the injured parts supervenes rapidly, and often renders a thorough examination difficult, if not impracticable. *Second caution:* It is not possible, after some weeks or months, to say definitely in certain cases whether such and such injuries have occurred, as, particularly in the case of dislocations, all traces of the original accident may rapidly disappear. Professional men should, therefore, be cautious not to judge their brethren unfairly. It is a disgrace for a surgeon to say six months after an accident that no dislocation existed. Yet such things have been. The surgeon called in to any case of this kind should, therefore, make notes for his own credit's sake. It is also well to make measurements in cases of dislocation. Bone-setters, on the other hand, are notoriously fond of making out dislocations where none exist. A certain amount of shortening and deformity may be unavoidable in cases of fracture. And a dislocated limb is seldom as strong as one uninjured. A fractured limb may, however, be stronger. It is important to remember that rheumatic gout (arthritis deformans) is specially prone to attack limbs and joints which have been injured by any accident, even by sprains. Such limbs are also more subject to œdema and other discomforts than sound ones.

Malapraxis in Obstetric Cases.

II.—As regards midwifery cases. Death occurring during or soon after labour is justly regarded as an event which ought to be exceedingly rare. But the relatives or friends may, and often do, blame the attendants when they are not responsible. Death may occur from strictly natural or unavoidable causes—as from shock, exhaustion, profuse bleeding in persons of the hæmorrhagic diathesis, from convulsions and coma, from previous disease of the lungs, heart, or kidneys, from apoplexy, from coagulation of blood in the heart, lungs, or limbs, (thrombosis and embolism), causing gangrene, from zymotic diseases, or from rupture of the uterus. No medical man or midwife is, however, justified in going on attending cases when there is reasonable proof that he or she is conveying the poison of puerperal fever from one case to another. It may be well to remark that the term "puerperal fever" is one used for several distinct contagious and infectious diseases attacking women in child-bed. The original cause may be scarlet fever in one case, typhus in a second, and erysipelas, or necrotic poison in another. When a surgeon has taken a retaining fee in any case, he is bound to attend, if it be in his power to do so, unless he be infected as described—or otherwise incapacitated. In such a case he should give due notice, or provide a suitable substitute, and he cannot claim the fee unless he attend, provided due notice be given him when labour supervenes. Owing to the uncertainty which attends the exact period of labour, and the numerous claims upon the time of medical men, it is both customary and proper to give due notice of the commencement of labour to the medical attendant. Except in rare cases, it is not the custom, nor is it necessary for an accoucheur to remain in continued attendance all through the early stages of labour. He should not, however, absent himself for any long period of time in any case when labour has really set in. Nor should he leave the house when it is over, without ascertaining that the uterus is properly contracted. He should visit the woman a few hours after, and ascertain for himself the absence or otherwise of hæmorrhage or other unfavourable symptoms. The state of the woman's bladder should be ascertained on the first visit, or the next day. It is also usual and proper to enquire if the child has passed urine and fæces with a view to discover any defective conformations as soon as possible. For the first week or nine days, visits should scarcely be at longer intervals than a day, or two in most cases. And no woman can be considered out of danger so long as the pulse keeps above 100, and the temperature above normal, or as long as any oozing of blood is going on, however slight. "Shiverings" at regular or frequent intervals are also a symptom indicating caution. It may be as well to state that it is not always possible to avoid rupture of the perinæum, particularly in first or instrumental labours. Vesico-vaginal and other fistulæ will also sometimes form even in labours where no assistance has been given, or after the proper and careful use of instruments. Several cases of "rupture of the uterus" have given rise to damaging comments at inquests, and sometimes to actions for malapraxis. The conditions which appear to predispose to this are, degeneration (usually fatty) of the uterine walls, prolonged labour, a large child, and sometimes unusual sharpness or prominence of the linea ileo-pectinea, or outgrowths from the bony pelvis, the use of ergot, or the injudicious use of such instruments as the crotchet, or forceps, might also assist. A great many of these cases, however, happen in the absence of the medical attendant, or midwife. The accident is not quite always fatal. Cases are recorded in which the neck of the womb has come away like a ring. This is called annular detachment of the cervix. (For references to rupture of uterus, *see* "Obs. Soc. Trans., vol. ix., p. 65 ; x. p. 40 ; xi., p. 9 ; *ib.* p. 204 ; xvi., p. 128 ; "New. Syd. Soc.'s Biennial Retrospect," 1869-70, pp. 410-14. [*Regina* v. *Popplewell*, *vide* "Med. Journals," 1869, passim.])* Through the rent in the womb, or vagina, the child may escape into the abdominal cavity, and, conversely, *the intestines may protrude.* Several instances are known in which the accoucheur has removed these with a knife or scissors. *See* case of Mr. Peacock, "Med. Journals." 1874. "Edinburgh Medical Journal," 1874. September, p. 284. Although this gentleman was acquitted at the Coroner's Inquest, he was afterwards sentenced to imprisonment for six months. It is scarcely necessary to state that no good could accrue from removing the intestines. In the case of *Reg.* v. *Dickinson*, Stafford Lent. Assizes, 1846, a surgeon was actually charged with causing his patient's death from following Sir James Simpson's advice in a case of Placenta Prævia. He was, however, acquitted. (As regards the *induction of premature labour, see Abortion* and *Infanticide.*)

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* The medico-legal bearings of rupture of the uterus, laceration of that organ, and of the vagina and perinæum have been discussed with much learning and a

Diameters of the Pelvis in Relation to Obstetric Operations.

We have elsewhere stated, that in strict law, no deformity of the pelvis justifies a medical man in inducing premature labour. Equity, however, rather than law, rules the practice of the Courts in this respect, or perhaps we should say, would rule them. For we have been unable to find a case in which a surgeon or accoucheur has been tried for the induction of premature labour, when the object has been to save life. Judges, however, frequently make the distinction, when addressing the jury in abortion cases of a criminal kind. The following tables, taken from Dr. Barnes on "Obstetric Operations" (p. 90), and from Dr. Ramsbotham, will secure the pretty general approval of the profession.

Scheme of Relations of Operations to Degrees of Pelvic Contraction under Labour at Seven Months.

Conjugate diameter reduced to—

1st	degree,	4 to 3¼	inches,	admits	spontaneous labour.
2nd	,,	3¾ to 3	,,	,,	of forceps.
3rd	,,	3¼ to 1½	,,	,,	of turning.
4th	,,	below 1½	,,	,,	of craniotomy.

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thorough practical knowledge of the subject by Dr. Robert Barnes, in his "Lectures on Obstetric Operations," 3rd edition [Churchills, 1876], Lecture XXI., pp. 320—375. It is impossible to do more here than refer to this valuable paper, and state Dr. Barnes' general conclusions, which are—(1) The non-pregnant uterus may burst; (2) The uterus may burst at any period of gestation, independently of labour proper; (3) Any part of the parturient canal may be lacerated during labour; (4) By far the larger number of cases occur during labour at term; (5) The uterus will not burst unless it be in a certain degree of tension, from containing something in its cavity; (6) The uterus may burst in child-bearing women of all ages; in women pregnant for the first time, or in women who have borne one or two children, the greater risk being in primiparæ, and in women who have borne *many* children; (8) "The uterus ruptures because there is a loss of balance and of due relation between the expelling power of the body of the uterus, and the resisting power of the parturient canal, the resisting power being in excess." Dr. Richardson recommends nitrite of amyl to quiet the uterus, in doses of iij minims to ʒj ether; (9) The uterine tissues may sometimes be quite healthy; but fatty degeneration is common. There may be cancerous degeneration, or the fibres may be exhausted by their over-work, like the muscles of a coursed hare. Stone in the bladder, and fibrous tumours may predispose. Pelvic contraction may be another cause. Ergot of rye and ignorant violence in tractile efforts may be a cause.

Cæsarian Section is unnecessary at Seven Months.

At the full term, according to Dr. Ramsbotham, there are four classes, viz.:—

Class I.—Pelves 4 inches antero-posteriorly by 5¼ inches transversely and upwards admit of	Natural labour.
Class II.—Pelves below the standard, and as low as 3 inches antero-posteriorly by 4 inches transversely admit of	The child being born alive by means of turning (version) on long forceps, &c.
Class III.—Pelves below Class II., and as low as 1⅜ inch antero-posteriorly, by 3½ inches transversely, or 1½ inches antero-posteriorly by 3 inches transversely . .	Only admit of craniotomy, cephalotripsy, or some other means of embryulcia.
Class IV.—All below the last necessitate . . .	Cæsarian section.

Dr. Barnes' table mainly agrees with this, and is as follows:—

Scheme of Relations of Operations to Pelvic Contractions, Labour at Term.

Conjugate diameter reduced to—

1st degree, 4 to 3¼ inches, admits	The forceps, opposed to the bi-parietal diameter of 3½ to 4 inches.
2nd degree, 3¾ to 3 inches, admits	Of turning, opposed to the bi-mastoid diameter of 3 inches.
3rd degree, 3¼ to 1½ inches, admits	Of craniotomy and cephalotripsy.
4th degree, below 1½ inches, admits	Of Cæsarian section.

Gordell is said to have delivered a child weighing 8lbs. 6oz. (living) through a pelvis whose conjugate diameter was only 2·82 inches, by turning. Madame Lachapelle says, she has thus delivered through pelves whose conjugate diameters were 2·75, 2·5, 2·25, and 2·2 inches. Most obstetricians think that there is some mistake in these figures. Gordell states that after using traction-power of 130lbs. on the child's neck, it has been born alive, and twice this happened after an audible crack! We have no details of the after-history of these cases. Dr. Matthews Duncan estimates that a traction-power of 105lbs. is compatible with the life of the child, the neck not yielding to that force. At 120lbs. the neck gave way. But Joulin states that he has applied a traction force of 148lbs. to neck of dead fœtus, without separating the head [*see* the "British Medical Journal," Sept. 19, 1874, p. 384, and "Dublin Quarterly Journal of Medical Sciences," Nov. 1875, p. 445].

III.—A medical attendant, midwife, or wet-nurse, may be charged with communicating syphilis during parturition or lactation, or by vaccination to mother and child, or to either of them singly. It cannot be denied that such an event is possible. A midwife at Brive in 1873 was said to have inoculated more than 100 persons in this way. Her sore was on the middle finger of her right hand, which had been wounded by a thorn. Her husband also had symptoms. She noticed the sore first on 18th February 1873. By March 6th she had lost all her hair. The sore infected all the cases she attended for eight months, from 28th February to 29th October. (*See* "Annales de Hygiène Publique," No. 85, July 1874.) She was condemned to a fine and imprisonment, not for giving the syphilis, but for practising as a sage-femme unlicensed, and preventing her victims from getting cured. Cases of infection of children by wet-nurses, and conversely, may be seen in "Diday on Infant Syphilis," pp. 187-200; ("New Syd. Society's Translation"); and Lancereaux on Syphilis, "New Syd. Society's Translation," vol. ii., p. 352, &c., with Bibliography). Mr. Hutchinson has lately ("Med. Chir. Transactions," vol. iv., 1871,) published cases of syphilis communicated by vaccination. Many of these cases, however, appear to us to be surrounded with considerable obscurity. The recent case of *Simpson and Wife* v. *Davey*, tried in the Queen's Bench, before Lord Chief Justice Cockburn, in December 1874, is one of such interest and importance, that a brief summary seems worthy of insertion. Defendant, a surgeon in large practice at Old Ford, injured the index finger of his right hand on the 18th March 1872 with a gun-cartridge. He attended a woman who was suffering from constitutional syphilis in labour on the 21st of March. (She died before the trial came on.) But on the 16th May, his finger still being sore, he attended the plaintiff's wife. He stated that he only used this hand to remove the placenta, and did not touch the woman. This was, however, disputed. On the 27th of May he consulted Mr. Hutchinson for what seemed a bad whitlow on the same finger. There was a measley rash on the chest, which soon assumed specific characters. He suffered very severely from syphilis. Whilst away for change of air, symptoms of syphilis appeared in plaintiff's wife, whom he had delivered. She allowed him, however, to attend her in a second confinement. The child then born had symptoms of hereditary syphilis. The case was complicated by an agreement which, though verbally repudiating liability, tacitly admitted it—and a verdict of £500 damages was agreed to by advice of the Lord Chief Justice, rather for breach of this agreement than on the direct issue. The medical witnesses (Messrs. Coulson, Heath, and Hutchinson included), agreed that the *period of incubation* in infecting sores or chancres, was much longer than usually supposed, from four to five weeks before the development of symptoms being common, according to the latter. All agreed that these cases are rare, and that chancres under the nail are difficult to diagnose. As there is often much dispute as to what are really syphilitic symptoms, we append the following table of the principal lesions met with in constitutional syphilis.

Early or Secondary Symptoms.

Six weeks to six months.

1. Sore throat, ulcers of tonsils, &c. 2. Roseolar, papular, and bullous rashes. 3. A fever of characteristic type *v.* "Clinical Society's Transactions," vol. iii., and "Das Syphilitische Fieber," von J. E. Guntz, Leipzig, 1873, and Wunderlich on Temperature "New Syd. Society," p. 405. 4. Indurated glands, small and bullet-like, not suppurating. 5. Iritis and other eye affections. 6. Loss of hair. 6. Patches and peeling of tongue and other mucous membranes, mucous tubercles. 7. Whitlow (Onychia). 8. Patches between fingers and toes called *Rhagades.*

9. Superficial sores of spreading type, with punched-out and undermined edges. 10. Neuralgic and rheumatoid pains. 11. Warty growths and condylomata.

Later or Tertiary Symptoms.

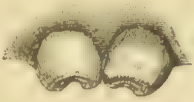
1. Nodes in the skin and connective tissue (Gummata). 2. Do. in muscles (muscular nodes). 3. Do. in periosteum of long bones (periostitis acute and chronic). 4. Ostitis. 5. Gummata in organs, such as liver, lungs, spleen, heart, kidneys, brain, &c. 6. Scaly skin-diseases, especially on palms and soles—psoriasis. 7. Rupia and ecthyma. 8. Troublesome deep ulcers, generally on one extremity—on both tonsils, pharynx, larynx, intestines, &c. 9. Warty growths. 9. Ozœna. 10. Iritis, optic neuritis and atrophy, choroditis and retinitis. 10. Exudation of lymph in and around blood-vessels, hence pareses, the distribution of which is often very bizarre. 11. Alopecia. 12. Severe and deep-seated pains, in the head and other parts. 13. A peculiar kind of phthisis.

Hereditary Syphilis.

In infants, more particularly in those who *inherit* syphilis, we get snuffles, thrush occurring a few weeks after birth, sores about the anus, &c., also between fingers and toes—and an aged precocious premature appearance. The child (cutting its teeth early) has an appearance of being older than it is during the first few months of life, afterwards growth and development are retarded. The advent of puberty is frequently postponed for years. *The central permanent incisors* are short, peggy, of bad colour, and *have a vertical notch, especially in the upper row.* [See Figs. 84 and 85.] In these cases there will generally be found symptoms in the parents—or the history of such—including numerous premature or still-births, or both. For further details reference must be made to the books quoted above.

FIG. 84.

A.

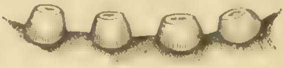


UPPER INCISORS.

IV.—Medical men may be charged with neglect for not attending sufficiently often, or sufficiently long, in an acute or chronic malady. These disputes generally arise where there has been some verbal or written, or at least understood or implied *agreement* to attend until recovery, or some other termination of the case exists. The custom of different districts differs widely as to the length of attendance in obstetric cases. In some parts of the country an accoucheur is supposed to attend for a month, if necessary, for the original fee. With the present value of money, this agreement could never be remunerative to the attendant. You are, however, bound by the "custom of the country," or district, unless you take care to have a clear understanding to the contrary. In other cases, not obstetric, a man of honour must hold himself bound by his word, "even to his own hurt," however inequitable or unjust the bargain may be as far as he is concerned. And although our courts generally hold that a medical man is the best judge of how often his attendance is necessary, yet they will, in disputed cases, hear the evidence of other medical men on this point, and form an independent

FIG. 85.

B.



LOWER INCISORS.

judgment on the facts of the case. In general, great pain, hæmorrhage, or any severe or urgent case will be held to necessitate frequent attendances. In the case of *Simpson and Wife* v. *Davey*, the Lord Chief Justice Cockburn distinctly laid down that a medical man might be held liable for neglect, in not visiting his patient, although not sent for, since the patient cannot be supposed to be the best judge of the danger or urgency of the case. He intimated, however, that if new and urgent symptoms (epiphenomena) set in, the patient or his friends were bound to give information of such to the medical attendant. This seems common sense as well as law, because, reverting to midwifery, you might leave your patient, after delivery, with the uterus well contracted, and she might afterwards be seized with hæmorrhage from her own imprudence, an event which you could not be expected to foresee.

V.—The *result* of operations is one of the issues on which an accusation of malapraxis is often raised against medical men, in most cases unjustly, since the result is often beyond our control. On this matter it is right you should remember that the simplest operations may be followed by untoward results. Such simple affairs as vaccination, and the extraction of a tooth (without anæsthetics) have been followed by death, not only as historical matters, but in the authors' own experience. So has the removal of the simplest tumours. In regard to this it is well to remember that cystic or bursal tumours near large joints, such as the knee, often communicate with the joint. Never do any operation without the consent of either the patient or his friends. If the patient be a minor, his or her consent, in the eyes of the law, is worth nothing. There may be some rare cases (perhaps in obstetric practice) where moral considerations might lead you to operate to save life even against the wish of friends or guardians. In such cases, however, you must, in following your conscience, be prepared for the legal risks. In the use of anæsthetics it is always well to have skilled, if not diploma'd, assistance if possible. The use of anæsthetics should be regarded as an operation in itself, for legal purposes. The existence of serious impediments to either circulation or respiration, and particularly fatty degeneration of the heart, are usually, and we think justly, regarded as objections to the use of anæsthetics. The same circumstances, with advanced degeneration of arteries, kidney disease, advanced phthisis, or any severe constitutional cachexiæ, also greatly interfere with the success of operations, and wise surgeons prefer only to do operations of necessity in such cases, and to use palliative treatment, rather than attempt a radical cure, even in such cases as stone in the bladder in such patients. There seems some doubt as to whether lithotomy or lithotrity be the safer in such a state of affairs.

In criminal trials it is often sought to fix the responsibility of a terminal erysipelas, &c., after trephining, or similar operations, upon the surgeon who operates, rather than upon the assailant whose violence caused the original injury. By parallel reasoning the traveller who was robbed by brigands would be in fault, because had he not been there he could not have been robbed. The question as to the best time for capital operations (such as amputation) after severe injuries, is one which can scarcely yet be considered as decided. In other words, is it better to operate at once, or to wait till the phenomena of shock have given place to reaction? In civil practice, the results of primary amputations (*i.e.*, done within twenty-four hours after the accident) are somewhat more fatal than *secondary* (those done at a later period) whilst in military practice, the reverse appears to hold good (*see* "Erichsen's Surgery," &c., pp. 26, 27, 28, &c.). The effects of mental depression were well shown in the late Danish, American, and Franco-German wars, the mortality after injuries and accidents being invariably greater on the losing side, even where other things were equal. In amputations the mortality is always greater the nearer to the trunk, or to any large joint. Overcrowding is a great cause of surgical mortality. Certain atmospheric conditions, such as north-east winds, are believed greatly to conduce to the prevalence of erysipelas. Want of cleanliness in the nurses or other attendants is another means of infection. Even flies, notably in the case of malignant pustule (charbon, milzbrand) have been the carriers of contagion. It will thus be seen that there are many circumstances over which a surgeon has but slight, if any control, which modify the results of operations. On the other hand he can, and will, if careful, prevent many disasters by proper precautions and prudent forethought.

It may be said, referring to malapraxis generally, that no medical man should give an adverse opinion on the conduct or practice of a professional brother, without having all the facts of the case before him; and whatever opinion he may give at an inquest, or in a Police Court, he should be prepared to justify before the higher tribunals, as well as before the whole of the medical profession. It has happened, though we hope rarely, that a medical man in condemning the practice of a brother professional, has only shown his own ignorance of the progress of science in general, and of medical science in particular.

VI.—The question of malapraxis may, and often does, arise in connection with the propriety, or the reverse of a special line of treatment, or more specifically, you may be asked, Was such and such treatment proper? Do you approve of such and such medicines, or of the doses employed? It is proper to remark here that however we may differ from homœopathy or hydropathy, these systems, deficient as they undoubtedly are, have acquired a certain recognition from the public, and it is not to be expected that adverse verdicts shall be given merely because the medical attendant *pro tempore* practised according to these systems. On the other hand, Mesmerism, Coffinism, and Morrisonianism have never acquired such a status, and are never likely to do so. Notwithstanding the remark made above, it is obvious that no "system," not even the "expectant" one of *nihilism,* can be reasonably held to justify treating a strangulated hernia, or a compound fracture, or dislocation, or a case of placenta prævia, or hæmorrhage from a divided artery by inefficient means, such as billionths of a grain of charcoal or any other medicament. On the question of *doses* again, even in orthodox medicine, very considerable latitude must necessarily be allowed, since even our best posological tables somewhat differ. But here again common sense must be consulted, and it may be said that no experience and no theory could be held to justify giving an infant of a month old $\frac{1}{2}$ grain doses of opium at frequent intervals as a dental sedative, or $\frac{1}{4}$ grain doses of strychnia as a tonic. The remarks on doses under the heading of poisons may be consulted on this point. Probably the best arbitrary standard of doses (other things being equal) will be found in the *weight of the body*, some deductions being made for the smaller weights, corresponding to the lesser ages. Thus, suppose a man weighing 10 stone

(140 lb.) can very safely take 15 grains of a drug (chloral hydrate) three times a day—then a child weighing 14 lb. might generally take $\frac{1}{10}$th, say 1.5 grains; or say for safety, disregard the decimal, and we get 1 grain per dose. The formula of Gaubius improved by Young, is also tolerably safe. The dose here is in the proportion of the age to the age increased by twelve, for all ages below twenty-one—thus say an infant is two years old, $\frac{2}{2+12} = \frac{2}{14} = \frac{1}{7}$, or as in the former case, about 2 grains of the chloral hydrate, for a child aged two years. However, it is usually wise to give *less* of narcotics and sedatives to young children, whilst they are believed to bear safely more of mercury, of antimony and other emetics. It is well to make yourselves familiar with the composition of the commoner patent medicines, vermin-poisons, and disinfectants.

Malapraxis as regards Lunatics, Idiots, and the Feeble-minded.

An erroneous impression appears to be prevalent in the medical profession, to the effect that medical men, as such, enjoy some special privileges, above those of the general public, as to the custody of persons of unsound mind—whether lunatics, idiots, or feeble-minded persons. In other words, not a few medical men, known to the authors, have imagined that by virtue of their diplomas, and position as medical men, they were entitled to take charge of lunatics, &c., *as patients* without complying with the requirements of the laws respecting lunacy, as regards certificates, licensed houses, &c., &c. You must know that so far from this being the case, the theory of the law is rather, that, as professional men, you are especially bound to know and observe the statutes on this subject. The state of the law on this point will be fully explained in our chapter on lunacy.

The same chapter will deal with the question of actions against medical men raised by patients under certificates, or the friends of such—or patients liberated from asylums, who accuse the medical men who have certified, of having falsely described them as lunatics, &c. It is therefore unnecessary here to do more than refer you to this chapter. [Chapter xxvii.]

CHAPTER XXV.

Criminal assaults—Indecent exposures—Rape—Physical signs of Virginity—The Hymen.—Signs of defloration.—Infantile Leucorrhœa.—Noma.—Illustrative cases.

Just as in common law, any touch, however light, such as putting the hand upon the shoulder, may be construed into an assault, if done during a quarrel or dispute ; so in the matter of criminal assaults, even a kiss, given or offered to one of the opposite sex, against his or her will, is considered a *criminal assault.* It must be almost self-evident that any touch, or attempt to touch any of the sexual organs, the breasts included, and even parts usually covered by clothing, is, in itself, of the nature of a criminal assault, if done against the will of an adult, or to a young child whom the law does not consider as capable of consenting. In the Prussian, and most of the German penal codes, such conduct is embraced under the general heading of "Unchaste Conduct." [See "Casper," *loc. cit.* Dr. Balfour's Translation, vol. iii., p. 276.] The French and other European codes contain similar provisions. Medical men are, however, not likely to be consulted on cases of this kind, unless actual violence has been offered. You must remember that syphilis might be communicated by a kiss. When, however, a rape has been committed or attempted, medical evidence is almost sure to be demanded. Before entering on the consideration of this subject, we must devote a moment or two to the consideration of the subject of

Indecent Exposures.

M. Devergie ["Médécine légale," 3me ed. tom. i., p. 342], justly remarks that "these cases are generally determined by the evidence of the bystanders, who furnish the necessary proofs." For this reason it is rare for medical evidence to be asked for in such cases. We believe, however, that in a very large majority of these cases, the accused would be found, on careful examination, to be suffering from some form of unsoundness of mind—in other words, from mental disease. We would not wish to be misunderstood. Undoubtedly there are scoundrels who infest our parks and other places of public amusement who richly deserve all the punishment the law inflicts. But it is very remarkable that in this country, as in France, not only are nearly all the accused of the male sex, but they are usually of advanced age—over seventy years for the most part. They are generally of no occupation, having either retired from business, or from the professions, or have private means of their own. [See Tardieu—"Etude Médico-légale sur les attentats aux Mœurs," pp. 3—8.] The figures given by M. Tardieu for France are very remarkable In the twelve years, 1858 to 1869, the numbers accused of outrages against public decency were respectively, 3,153 ; 2,905 ;

2,823; 3,351; 3,389; 3,225; 3,222; 3,248; 3,050; 2,763; 3,084; and 3,019; figures which give a mean of 3,102 for a single year. If the patient be a female,—as in the instance of the young girl mentioned by Tardieu [*loc. cit.*, p. 6], who exposed herself shamelessly, and openly solicited intercourse from all the men, and even boys she met,—she will probably be found either imbecile, or afflicted with hysterical mania. Extreme sexual passion, is called erotomania in both sexes, nymphomania in the female, satyriasis in the male. The subjects of puerperal mania sometimes display this form of insanity. Epileptics of both sexes, imbeciles, and general paralytics are most prone to this peculiar and disgusting form of sexual aberration. Pope's well-known line, that—

> "Want of decency is want of sense,"

is literally true. If, therefore, you should be consulted on any case of this kind, it would be your duty to make a strict enquiry into the sanity or the reverse of the accused. The law is very properly strict in requiring full proofs of such a defence. There are, however, one or two conditions, apart from insanity, which sometimes lead to innocent men being accused of indecent exposures. These are (1) very studious or busy people are often subject to what is called "absence of mind,"* and such persons often forget to "adjust their dress" on leaving public conveniences. (2) Certain diseases may cause the frequent application of the hand to the sexual organs or their vicinity. Of these the chief are *large scrotal and other herniæ*, *pruritus ani*, *eczema*, *impetigo*, and other diseases in which itching is a prominent and painful symptom; *Prolapsus* or *procidentia ani*, perhaps *varicocele*, *hydrocele*, and other scrotal tumours; and in the female, *prolapse of the uterus*, and diseases analogous to those of the male just mentioned, With this remark we must dismiss a very unsavory subject, and proceed to the consideration of rape.

Rape. General considerations, and Questions connected with Virginity and Defloration.

A great number of questions in connection with this subject, may be asked of the medical jurist. Tardieu (*loc. cit.*) gives twenty-four questions on this topic, of which the most important are:—1. Are there any traces of the crime? 2. Are the physical signs the result of bad habits? 3. Is the discharge present the result of contagion? 4. Has there been actual violation? 5. What is its date? 6. Is the injury inflicted by the male sexual organ, or due to accidents? 7. Is death due to the violation? or (8), did murder precede rape? 9. Can a woman be deflowered whilst unconscious, as in sleep, or in magnetic trance, &c.? 10. Can rape be followed by impregnation? 11. Is rape possible, if the woman resist, unless the man be assisted? 12. Of what nature is the disease of the victim, and what is its date? 13. Is the disease of the accused of the same kind? 14. Are there any physical impossibilities precluding the accused from committing this crime. 15. Is there any popular notion that explains the attempts often made on young girls. 16. Can a man, during sleep, have sexual intercourse unconsciously?

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* "Absence of mind" is often, in reality, a "st tus epilepticus" or form of "le petit mal," of which "le grand mal" is epilepsy.

17. Does the accused present any personal peculiarities? 18. Of what nature are the stains on the clothes of the victim or of the accused? 19. Can rape be simulated? Without adhering strictly to the exact order of these questions, we hope to answer them all so far as the present state of science allows.

The legal definition of rape is "the carnal knowledge of a female by force and against her will," but in a very large proportion of the cases sent for trial, the attempt is made, or supposed to be made on the persons of young children. There are several reasons for this. One is the popular superstition, alluded to above, that if a man, suffering from gonorrhœa have intercourse with a pure virgin, he is supposed to be cured in consequence. We need hardly say there is no truth in this notion. There can, however, be no doubt that it is very widely prevalent, and disgusting as it may seem, it is no less a fact, that old women doctresses not unfrequently prescribe this criminal attempt to young men who consult them for urethral discharges. Another reason is doubtless to be found in the feebleness of children. For reasons which will be stated hereafter, many of the false accusations relate to children, who are often terrified into making false statements.

The crime of rape was formerly punished by castration by the laws of many countries. Dr. Taylor quotes Dr. Griffiths, to the effect that in Virginia and Missouri this is still the legal punishment, if a black man violates a white woman. Death was formerly the punishment in England, until by the 24th and 25th Victoria, s. 48, penal servitude or imprisonment was substituted.* It is said that since this alteration in the law, the crime has enormously increased [" 57 per cent. in four years," "Law Times," 4th January, 1845, "90 per cent.," according to the statement in Parliament in 1847-8. See Taylor, *loc. cit.*, 439]. The Jewish law ("Deuteronomy," xxii., 23-25), punishes the rape of betrothed damsels with death—if not betrothed, the man was to pay a fine, and marry the girl without the option of divorce. Michaelis contends, however, that for simple rape there was no punishment in the Jewish law, except that of marriage. Beck, in his chapter on this subject, has collected the laws of many countries, ancient and modern, on this crime, some of which are exceedingly curious [*loc. cit.*, pp. 95-107]. "Among the Athenians rape was punished with death; and by the Roman or Civil law, with death, or confiscation of goods [Gibbon, vol. ii., p. 252. Law of Constantine]. The latter, however, ordained, 'Rapta raptoris, aut mortem, aut indotas nuptias optet,' and upon this, says Dr. Percival, there arose what was thought a doubtful case, 'Una nocte quidam duas rapuit, altera mortem optat, altera nuptias.'" ["Medical Ethics," note 17, p. 231.]

The English law appears to have been frequently altered. Fines, imprisonment, loss of all the sexual organs, castration and loss of eyes (William the Conqueror); degradation, including the horse, greyhound, and hawk of the offender; death; and finally penal servitude, and imprisonment, with or without hard labour, having all had their turn. We need not follow Beck or other authors, who have written on this subject in all their antiquarian researches, however interesting, since in almost all civilized countries the extreme penalties have been abrogated, just as capital punishment has been abolished in nearly all crimes except those of murder, high treason, or bestiality. Yet it is clear that all civilized nations in both ancient and modern times have set, and justly set, a very high value upon female chastity; and rightly so, since it is the bond and security of almost all social virtues, and of family happiness; and most intimately connected with the well-being, and even political integrity of states. For reasons which are obvious this crime is usually attempted when the victim and the ravisher are alone, or supposed to be so by the latter. It is no doubt for this reason that the evidence of one witness, viz. the victim or complainant, is all the legal proof absolutely necessary. As, however, false accusations are exceedingly common (twelve false to one true, according to Professor Amos, see Taylor, *loc. cit.*), the judges of late years have generally required corroborative evidence of some kind; and medical testimony is usually sought in such cases. In old times both English and Scotch judges required proof of both *penetration* and *emission* on the part of the male. But by the 24th and 25th Victoria, c. 100, s. 63, proof of penetration only is demanded. In a case reserved for the consideration of the judges by Coleridge, J. and reported in 9 Carrington and Payne, the principle was admitted that a sufficient degree of penetration to constitute rape in law may take place without necessarily rupturing the hymen. " Penetration to the vulva is sufficient to constitute the crime. [See also *Reg.* v. *Lines*, 1 Carrington and Kirwan's Reports.] From the decisions of our judges, vulval penetration, with or without violence, is as much a rape as vaginal penetration." [Taylor, *loc. cit.*, pp. 441, 442.]

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* "Whosoever shall be convicted of the crime of rape shall be guilty of felony, and, being convicted thereof, shall be liable, at the discretion of the court, to be kept in penal servitude for life, or for any term not less than three years, or to be imprisoned for any term not exceeding two years, with or without hard labour."

This question was similarly decided by the Scotch judges, in the case of *Macrae*, in the High Court of Justiciary, 1841. [See Cormack's " Edinburgh Journal," January, 1846, p. 48.] In our opinion this is not only good law, but common sense. That a scoundrel who attempts the chastity of a child or a young girl should escape punishment merely because her youth, or the imperfect development, or narrowness of the parts prevent his fully consummating the crime, appears to us as undesirable as it would be unjust. For like reasons the law accepts the evidence of witnesses of very tender age [that of complainants of seven years of age has been several times received], provided it be on oath, and that they are sensible " of the nature and consequences of an oath, and of the danger and impiety of falsehood." [East's " Crown Law," vol. i., p. 444. *Brazier's case*, before the twelve judges, 19 Geo. III.] On this subject, see our remarks at p. 650.

These general considerations lead us naturally to the consideration of the

Physical Signs of Virginity.

As we have frequently heard the most ludricrous mistakes made in courts of law, not only in trials for rape, but in those for infanticide and child-murder, in regard to the names given by anatomists to the different regions of the female pudenda or sexual organs, it seems to us not quite unnecessary to briefly describe these organs as they exist before and after puberty. In so doing, we have chiefly followed (as regards the external genitals) the excellent description of M. Tardieu. [*Loc. cit*, p. 26, &c.]

The *mons veneris*, or lower triangular portion of the abdomen, is the rounded eminence immediately above the *vulva*, formed by a fatty cushion, or collection of adipose tissue beneath the skin. Hairs begin to grow upon it even before the full completion of puberty. Both hair and fat are most abundant in young adults; whilst in old age most of the fat is absorbed, and the hair becomes much thinner. As regards rape, this part may be the seat of bruises, scratches, and extravasations of blood; and in the case of young adults, spermatozoa may often be detected on the hairs of this part, especially if the assailant have been disturbed. The microscope is of course requisite. [See p. 577.]

The *vulva* is a general name given to all the female genitals which are *outside* the hymen. These include the greater and lesser *labia*, *clitoris*, *fourchette*, *navicular fossa*, and *meatus urinarius*. We will take them in order, first making one or two general observations. Our first remark, following Tardieu is, that different females, even of the same age, present an almost infinite variety in regard to the appearance of the genital organs, and the development of the different parts. As medical witnesses you must be careful not to describe as disease, or as the result of violence what is perhaps only the natural conformation of the part. Those familiar with obstetrics, and with the treatment of children, will be best able to give evidence on such points. Again, MM. Devergie,* Toulmouche, and Tardieu justly remark, that of the two kinds of organs united in one in the female genitals, the urinary organs predominate in infants, and the genital in women and marriageable girls. Thus, in little girls, one often sees the vulva gaping at the upper part, so that the meatus, or orifice of the urethra is visible, and closed below; whilst in adults we see just the reverse, the intermediate ages presenting modifications. Tardieu adds, correctly, that the opening of the vulva is directed directly forwards in infants, and not obliquely from above downwards.

Again, M. Dolbeau points out that the external parts may be divided into two divisions—one vulvar, the other vaginal, separated by the hymen. In front of the hymen there is a sort of vestibule, which M. Dolbeau calls the vulvary canal, formed from before backwards by the greater and lesser labia; above is the clitoris, the bulb and the cavernous bodies extend along its sides; and below is the fourchette, and the navicular fossæ. The length and depth of this canal vary greatly; and frequent and repeated outrages on young children bring about characteristic alterations in both the form and dimensions of this canal.

The *greater and lesser labia* or lips.† The greater are also the external, and in the adult usually conceal the lesser labia or *nymphæ*, which are internal. There are, however, many exceptions to this. At birth the lesser labia are generally external. It is said that sexual excitement, and repeated irritation by touches, &c., are frequent causes of hypertrophy of the nymphæ. The varying size of the larger and lesser labia is the chief cause of the variety of appearance just mentioned.

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* "Médécine légale," 2nde edition, tome i., p. 342.

† The singular form Labium is only correct when speaking of the lip of one side, right or left labium.

The *clitoris*, a miniature and imperforate penis, varies greatly in size. Sexual excesses are believed to cause hypertrophy of this organ. The authors have, however, frequently seen a small clitoris in women who were hetairæ.

The *fourchette** and *fossa navicularis* are names given respectively to the posterior or lower border of the vulva, just within the posterior *commissure* or meeting of the greater labia, and to a sort of *cul-de-sac* of a boat-like form, which intervenes between the former and the hymen.

If the *fourchette*, which forms a kind of bridle, stretched in front of the vagina, and the *fossa navicularis*, do not disappear in consequence of defloration, they are pretty sure to do so in the first labour. After this the vulva remains more patent below and behind than it is above and in front.

The *hymen*, or maiden-head (Bucton), is a thin membrane, which is in reality the prolongation and termination of the vagina in the vestibulum of the vulva. It is visible at birth, but is very deeply placed in very young girls, and can only be seen by very widely separating the thighs, and at the same time opening the greater labia widely. It is then found at a depth of about ¼th or ⅓rd of an inch from the orifice of the vulva. At a later period of life it becomes more superficial, and more readily seen. As the sign *par excellence* of virginity in a physical sense, it deserves particular consideration. Modern anatomists and gynæcologists can scarcely understand how it was possible for ancient authors to deny the very existence of an organ, which is not only found in the human female, but in other mammalia.† Devilliers found it in 150 cases in a special inquiry on the subject ["Revue Médicale," 1840, tom. i.]; Orfila in 200 cases ["Traité de Médecine légale," 4 édit., Paris, 1848, tom. i., p. 135]; and Tardieu in more than 600 cases [*loc. cit.*, p. 29], never failed to find this membrane or its *débris*. The authors have been able to verify the existence of the hymen in nearly 1000 cases. The exceptions in modern times to this rule [of finding either the hymen or its remains] are, for the most part, either badly reported, or have been disproved by subsequent investigations. Casper records several cases in which medical men denied the existence of a hymen, which was nevertheless not only existing, but sufficiently evident on proper examination.

M. Tardieu mentions five typical forms of the hymen, to one or other of which all the varieties which are numerous, may be referred. These are :—

A. The primary form, most common in infants, and often met with up to the period of puberty, is what we may call a *labial* arrangement of the membrane, with a vertical slit communicating with the vagina. This form resembles the cloaca or anus of a pullet. [Fig. 86.]

B. In a second form, the hymen forms an irregularly circular diaphragm, pierced towards its upper third by an opening of more or less size, and situate at somewhat varying height. M. Roze found one in the Anatomical Museum at Strasburg, in which the opening was on the right side of the upper part of the hymen. This second type is more common than the next three. [Fig. 87.]

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* The posterior commissure of the labia is sometimes called fourchette.

† Amongst those who denied its existence were Ambrose Paré, and the celebrated Buffon.

C. The third form is really circular, and the orifice central. [Annular form of English Authors. Fig. 88. It will be seen that the artist has made this rather too oval.]

D. In the fourth form, which MM. Devilliers and Devergie seem to have met with most commonly, the hymen forms a semi-lunar diaphragm, in the form of a crescent, the concavity of which is superior, and its edges are indented more or less. The extremities or horns of the crescent are lost in the nymphæ. [Fig. 89.]

FIG. 86.

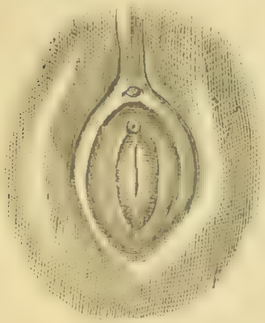
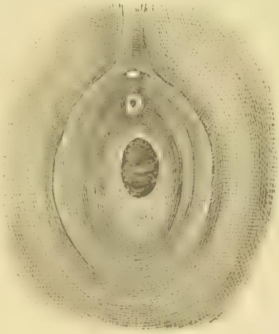


FIG. 87.



E. Lastly, the hymen sometimes consists of a simple circular or semi-lunar riband, or fillet, attached to a sort of fold or fringe, constituting a kind of double nymphæ, and varying from $\frac{1}{12}$th of an inch in very small girls to $\frac{3}{4}$th or $\frac{1}{3}$rd of an inch in adults. Sometimes, according to Tardieu, it forms a sort of rim or collar-like ring, slightly raised above the level of the vaginal orifice. These peculiar forms are probably present in many of the cases where the hymen has been supposed absent [MM. Tardieu and Toulmouche.] Other peculiar forms have been noted by Cloquet, Morgagni, and others, such as a hymen like a curtain, looped up on each side so as to have two lateral openings. Roze has described such under the name of "biperforate." Fabrice de Hilden has described a "cribriform" or sieve-like hymen, pierced with holes. Some of these forms are probably the result of lacerations. Lastly, obstetricians know that the hymen may be "imperforate," completely closing the vagina. [The operation for cure of this has not infrequently been fatal.] The

FIG. 88.

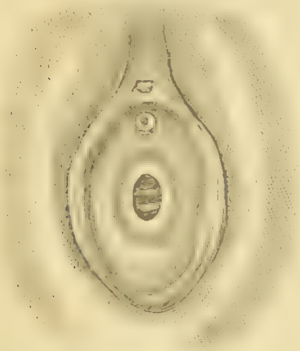
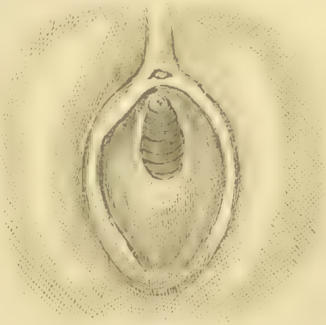


FIG. 89.



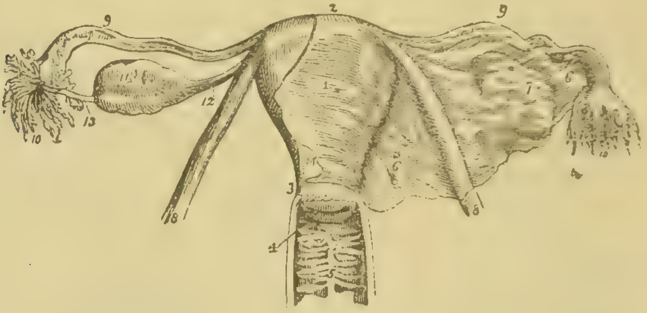
hymen may also be double [reduplicated]. Various changes take place in the hymen as years go on. [Tardieu, *loc. cit.*, p. 32.] It sometimes becomes extremely tough, or it may even undergo fibrous, cartilaginous, or almost osseous degeneration—and become so resistant as to enable Diemerbroek to say—" Adeoque firmam invenimus, ut cujuslibet arietantis viri impetum sine disruptione sustinere potuisset ! "

The *carunculæ myrtiformes vel hymenales*, three to six in number, are now generally regarded as the remains or débris of the hymen, although it is possible that two or three of them may belong to the ridges of the vagina. Little polypi, warts, vegetations, &c., may sometimes be mistaken for them.

Little need be said of the orifice of the urethra (*meatus urinarius*) or the bulbs (*bulbi vestibuli*), except that the bulbous structure beneath the urethra is sometimes prolonged into and completes the upper part of the hymen, and this explains the excessive hæmorrhage which sometimes accompanies the destruction of the hymen in the first coitus, of which the authors have seen two instances which almost proved fatal. (See Rouget in the " Journal de la physiologie de l'homme," Paris, 1858.)

The *vagina* is the membranous-muscular tube between the vulva and the uterus, intended for the reception of the male organ. There are great diversities in the dimensions of the orifice in the hymen according to age and development. In the very young infant the orifice of the hymen barely admits a goose quill ; towards puberty, perhaps the tip of the little finger. Even in adult females it rarely admits more than the tip of the index-finger, unless it has been previously dilated. It is important to note this, as more or less dilatation of the hymeneal orifice of the vagina may furnish evidence of attempts against chastity. In the virgin the vagina itself is narrow. This is partly due to its muscularity.

FIG. 90.



Relations of the unimpregnated uterus, vagina, ovaria, fallopian tubes, and round ligaments.

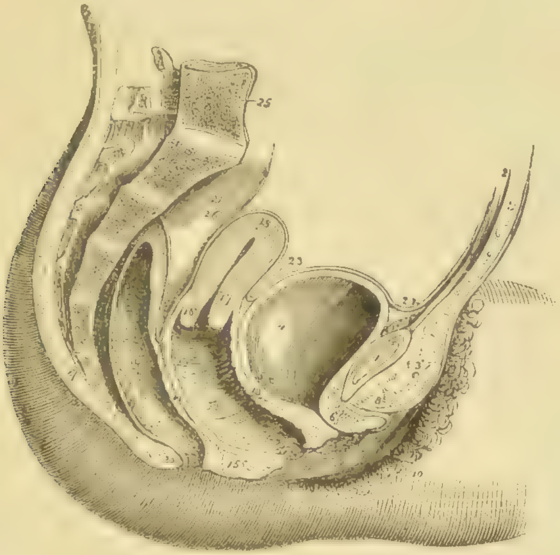
Lastly, the skeleton in young children, owing to partial development of the pubic arch, is often a more complete obstacle to the complete introduction of the male organ than any conformation of the soft parts.

Figs. 90 and 91 may further assist in the comprehension of this chapter, and of those on abortion and infanticide, &c. In Fig 90, 1 is the body of the uterus ; 2, its fundus ; 3, its neck or cervix uteri ; 4, the os uteri ; 5, the vagina, showing its rugæ ; 6, the broad ligament of the left side ; 7, the left ovary ; 6, the fimbriated extremity of the fallopian tube; 8, the round ligament; 9, 9, the fallopian tubes; 11, the other ovary; 10, the fimbriated extremity of the right fallopian tube.

Fig. 91 is a side view or section of the female pelvis. 1 is the symphysis pubis; 2, the abdominal wall; 3, the mons veneris; 4, the bladder; 5, its trigone; 6, the urethra; 8, the clitoris; 12, the vagina; 15, the perinæum; 16, 17, posterior and anterior lips of os uteri; 18, fundus of uterus; 19, rectum; 20, coccyx and anus; 25, promontory of sacrum [Further explanations in Wilson's "Anatomist's Vade Mecum."]

The "physical signs," which indicate virginity, are generally considered to be the following: 1. The presence of an intact hymen. 2. The absence of the carunculæ myrtiformes. 3. The fourchette, fossa navicularis, and posterior commissure of the labia being entire. 4. A narrow and rugose state of the vagina. 5. A plump, elastic condition of the breasts, with slight development of the nipples. 6. Integrity of the perinæum. A few remarks must be made on all of these.

FIG. 91.



Our first remark is that no one of them, taken alone, is an absolute proof of [physical] virginity, although the presence of a perfect hymen is very strong presumptive evidence of chastity. Just as in the case of pregnancy, all the signs, or at least several of them, must be taken together.

I. First, as to the *hymen*. When this is found intact, we cannot too strongly insist with Devergie* and Casper,† that "*this is the most valuable sign of all in a diagnostic point of view.*" It is relied upon amongst the Jews, both ancient and modern. ["Deuteronomy," xxii., 15-20], and even yet, according to Beck, the "shift of honour," [*Camiscia dell' onore*] is proudly exhibited to the bride's friends in Naples, as well as in eastern countries. Of late years experienced obstetricians, such as Drs. Tyler Smith, Oldham, and Barnes have sworn to the fact of females whom they have examined being "*virgines intactæ*," chiefly on the ground of the integrity of the hymen—and their evidence has been received in the superior courts, and verdicts given accordingly Although Madame Boivin and others have written as to the ease with which the hymen may be destroyed "by many innocent introductions," the authors have seldom found it destroyed by self-abuse, except when very excessive, nor by scratching due to the presence of worms or other causes of irritation in children. And although it has been alleged that riding, dancing, leaping, or the passage of clots in menstruation (!!!) as Fodéré and Belloc assert, may and will destroy the hymen; the authors do not believe that this is anything but an event of extreme rarity from any of the causes mentioned. The hymen is too deeply placed for this. It has been found in many aged people. Gavard found it at the age of 50, Bennach in a woman aged 60, Devergie at the Morgue at ages of 65 and 70, and the authors know of instances at 80, and 92 years of age.

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* He very justly remarks (op. cit., p. 346) that when a hymen is *not* found, in 999 cases out of 1,000, defloration has actually occurred.

† *Loc. cit.*, vol. iii., p. 281.

Dr. Norman Cheevers (*loc. cit.*) states that the parents of young Indian girls often use mechanical means to dilate the vagina, in order to render immature girls *aptæ viris.* The fruit of the plantain is a favourite instrument. It is said by missionaries that similar means are employed by Africans, and by the Chinese. *Casper* speaks of a case in which the hymen was lacerated by the child's mother, first by the fingers, then by a long stone introduced into the vagina! [*loc. cit.*] Tardieu gives similar cases. The authors know of others from the breaking of a crinoline steel hoop, and the breaking of domestic utensils. A curious case is recorded in the "British Medical Journal," of a goat attacking a young woman whilst straddling to cross a stile—the goat being behind her. Brantôme gives a similar history, from a thrust with a sharp cane, during micturition!! But such accidents are, after all, rare, and we feel it our duty to repeat the words of Casper most emphatically—when he says, "Not assenting to that unfounded scepticism which has been asserted in regard to this question, both in earlier and more recent times, I must declare, that when a forensic physician FINDS A HYMEN STILL PRESERVED, EVEN ITS EDGES NOT BEING TORN, AND ALONG WITH IT (in young persons), A VIRGIN CONDITION OF THE BREASTS AND EXTERNAL GENITALS, HE IS THEN JUSTIFIED IN GIVING A POSITIVE OPINION AS TO THE EXISTENCE OF VIRGINITY, AND *vice versâ.* As he justly remarks, those cases in which pregnancy has been observed along with a hymen [Walter, Hellmann, Osiander, Naegele, Fodéré, Kruger, Heim, Casper, and several British cases], do not really make any difficulty, because in these rare cases we have the signs of pregnancy also. It is said that in one case a five months' fœtus was extruded without injuring the hymen. This case is, however, not very carefully reported, and it is generally agreed that labour at term could not possibly take place without this membrane being destroyed, either by the accoucheur, or *in partu.*

II. As regards the *carunculæ myrtiformes,* note that two or more of these are said to be vaginal, not hymeneal, and may therefore exist with the hymen; and again, the presence of these little bodies only proves the destruction of the hymen, and does not necessarily prove rape, though they may corroborate it.

III. The fourchette, posterior commissure, &c., seldom or never survive even a first labour at term. They are, however, but little affected by sexual intercourse, except under circumstances of extreme violence. The same may be said of

IV. A narrow and rugose state of the vagina which is common in healthy young married women, previous to child-bearing, and sometimes after a single confinement at an early age. In this case, however, we should probably find changes in the Os uteri and perinæum. It is said that astringents keep up the contractility of the vagina—and thus simulate a virgin state.

V. The condition of the breasts is a good deal affected by age, also by the general health.

VI. The perinæum is almost invariably lacerated a little in first labours. Its integrity, however, is not affected by sexual intercourse, unless this be extremely violent. We now pass to the

Physical signs of Defloration and Mode of Examination.

Dr. Taylor advises very properly, that whenever a medical man is asked to examine a young girl or woman, who is alleged to have been raped, or violated, he should note down at once the exact time (if possible, by a public clock) as well as the date, name, and appearances. Next, let your examination of the child or woman brought to you be thorough, at the same time that it is gentle. In the case of children and young infants, it is generally necessary to have assistance. Dr. Davis in his "Obstetric Medicine," p. 98, justly says: "In examining for the hymen in cases of rape, or for purposes of professional treatment in many other cases, it will be necessary to separate the labia, and even the thighs, to a considerable distance from each other, before the hymen, in the event of its being present, can be distinctly seen." In the case of those who have attained puberty, the sexual hairs will often be found to have spermatozoa adhering to them [Casper.] The clothing also of the victim and the accused should be examined for spots. In the case of young children, a glass pipette or a curette should be used to remove some of the discharges, and mucus from the vagina, which sometimes retain living spermatozoa for ten or even fourteen days after the rape [Beale's Archives]. The duties of a medical jurist in cases of accusations of rape may be divided into A, the examination of the victim; B, the examination of the accused; C, the examination of stains on articles of clothing worn by either; D, making a report of these examinations and their results, with the conclusions drawn from the facts observed. Taking them in order; in the examination of the victim we have (1) the examination of the organs of generation; and (2) the examination of the rest of the body for marks of violence. The first part, or examination of the genitals, will be a farce, unless you are familiar with the physical signs of defloration, and with the appearances of these organs due to disease. It is for this reason that we begin with the appearances presented by

Destruction of the Hymen.

For anatomical reasons given above, the rupture of the hymen sometimes causes very severe hæmorrhage, which may even be fatal. Figures 92 to 95 show various forms of laceration met with [after Tardieu] from one or more simple slits, to double perforation, and wide-stretching of the parts. The general rules of surgery as to wounds are applicable here. The recent are sharper edged and fresher looking, and more tender; the older ones have more rounded and callous edges, and are less tender. These figures are only diagrammatic—in real cases there would usually be more injury to the rest of the vulva, and especially its lower parts (fourchette, &c.) Fig. 95 is the result of *repeated* introduction of foreign bodies of some kind or other. Fig. 92 is the commonest form of laceration. The others, though less common, are sufficiently frequent. If no fresh attempts at violation or introduction of foreign bodies be made, the floating folds of torn hymen may last for many months [Devergie and Tardieu, *loc. cit.*].

Fig. 92.

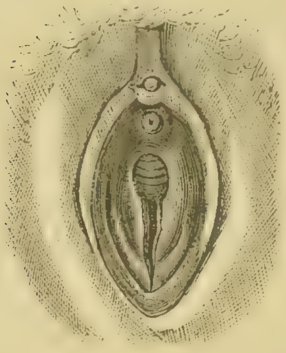


Fig. 93.

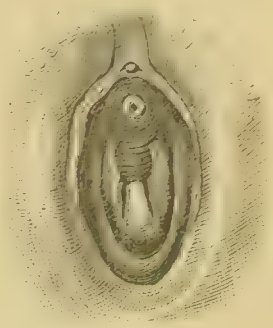


Fig. 94.

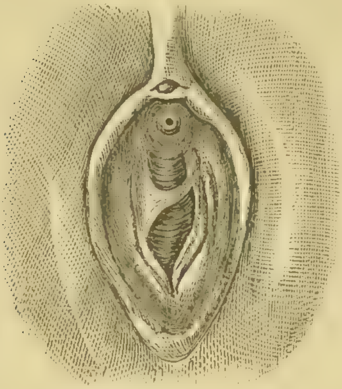
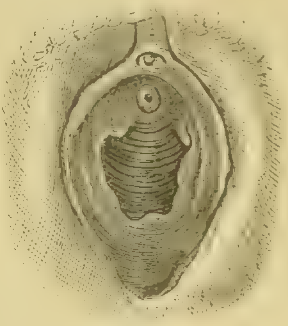


Fig. 95.



Other Signs of Violation.

(1) There may be blood, as previously stated, in the vulva.

(2) All the vulva may be swollen, red, hot, and tender.

(3) There is a muco-purulent discharge, if the violation occurred from two to four days previously. [In one case the authors saw pus formed in twenty-four hours. It was a genuine case of rape, spermatozoa being found in large numbers, and there was no pus until the period named.]

(4) Dr. Taylor states that the vagina may appear dilated. In really recent cases our experience is that the swelling makes it appear more

contracted. You must be very careful not to mistake infantile leucorrhœa, noma (or gangrene of the pudenda), and chronic gonorrhœa or syphilis. On each of these we shall make some remarks. Owing to the pain caused by the disproportion between the penis of an adult male and the genital organs of a small child, there is usually resistance on the part of children of tender years. You will therefore examine for scratches, bruises, and other signs of injury. These are most likely to be found (*a*) about the thighs and vicinity of the genital organs (*b*), on the arms, legs, and front of the body. In the case of females after puberty, you may have to consider the possibility or probability of the injuries being *self-inflicted*, as the accusation of rape is one often made from motives of spite, or to extort money. Such voluntary injuries are generally of a slight nature, and in parts easily reached by the hands, such as the vulva, inside of the thighs, &c.

(5) If the *carunculæ myrtiformes* be present, this is a sign not of recent but of previous defloration. The same may be said of

(6) A dilated condition of the vagina. In regard to this we hold that the condition of the vagina is of very slight value in a forensic point of view, as instances are known in which women who have had repeated sexual intercourse, and even had children, have presented a narrowness of the vagina, exceeding, or at least equalling, that of a virgin. It can scarcely be necessary to inform those of you who are familiar with anatomy and physiology, that *the hymen, once* destroyed, *is never renewed;* so that the only sense in which virginity can be said to be renewed is in the narrowness and healthy tonicity of the vagina and external parts. We mention this, as a well-known passage in Boccaccio appears to teach a different doctrine.*

(7) The condition of the *breasts*, again, though affected by lactation, and by frequent manipulations, is scarcely affected by the mere fact of sexual intercourse.

(8) The signs already given of previous child-bearing [see p. 705, &c.], though proof positive of the absence of a virgin condition, are seldom available in a case of this kind.

(9) The virgin or nulliparous state of the os and cervix uteri (see p. 709) is little affected by sexual intercourse simply, only by the pregnant condition. Certain tumours and diseases may simulate the changes induced by pregnancy.

Proofs of Violation from Stains in Clothing, &c. &c.

We must refer you to the chapter on seminal stains for the description of spermatozoa, and the means of detecting them. Again, reminding you not to forget to examine :—(1) The clothes of the victim, if you can get those worn at the time of the alleged rape. You will often find they have been *washed;* but this must be regarded as a suspicious circumstance, since complaint ought to be made at once in a genuine case; (2) Examine the vaginal mucus for spermatozoa. Do not mistake fungi or trichomonades for the seminal animalcules. The sexual hairs of older females should also be examined (Casper), as spermatozoa often adhere to them; (3) The shirt and drawers of the accused should also be examined, if the charge be recent; and his person for signs of syphilis or gonorrhœa, especially as the latter often furnishes a motive for the crime. The discharges in such a case are muco-purulent; but there are no very definite microscopical characters distinguishing venereal stains from those of simple urethritis and other sores. The *absence* of blood, or other stains on the clothes of the accused, is not always a proof of innocence; see case quoted by Dr. Taylor (*loc. cit.* pp. 444-5), in which the boy was examined before he had time to change his clothes. Presuming you have found injuries about the child, or older female examined, you cannot say that they actually were produced by the *penis*, since the fingers or other instruments might produce similar injuries. In the case of an infant, aged eleven months (named Hall), a soldier, named *Hume*, who was drunk, is said to have inflicted the fatal injuries with his fingers. This is, however, in real truth, as much violation as the other.

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* "Essa, che con otto nomini forse diecemilia volte giaciuta era, allato a lui (al Re del Garbo) si coricò per pulcella, e fecegliele credere, che così fosse; e Reina con lui lietamente poi più tempo visse; e perciò si disse: Bocca basciata non perde ventura, anzi rinnuova, come fa la luna."

To the question, "*Is rape, or violent sexual intercourse, often fatal?*" you must unhesitatingly answer, "Yes." The case above quoted, the famous case of *Amos Greenwood*, to be presently mentioned, and numerous cases by Tardieu, Casper, Taylor, and others known to the authors, show that death not unfrequently results. This may be a consequence of shock, of hæmorrhage, of the after effects of wounds, and in the case of females at or near puberty, of a general state of erethism, or extreme congestion of the sexual organs, and of the brain and spinal cord, which may lead to hæmorrhages in nervous matter, to arrested circulation in the lungs, to apoplexies of the ovary, and to effusion of blood into the peritoneal and other cavities. The authors know of several unpublished cases of this kind. That the male organ of a vigorous male may inflict frightful injuries upon a young and immature female, is abundantly shown by Dr. Norman Cheevers (*loc. cit.*), from civil practice amongst the Hindoos, and is also within the experience of the authors, even in cases where there was no criminal intent. The vagina may be torn through into the bladder and rectum, the perinæum quite destroyed, and the peritoneal cavity opened by the force of the male organ only.

Diseases simulating the Effects of Violation.

The first fact with which you should be familiar is, that very young females, infants, and young children are subject to inflammation of the vulva (*vulvitis*) and vagina (*vaginitis*), giving rise to what is called *infantile leucorrhœa.* Thread-worms (oxyurides and trichocephali dispares, commonly called ascarides), are a frequent cause of this. But in scrofulous and delicate children, dentition, catarrh, loaded bowels, and other causes, produce similar effects. See an able paper on this subject by the late Sir W. Wilde ["Medico-Legal Observations," &c., 1853.] The subject is now treated of by most obstetric authors, and in most works on diseases of children. [See Meigs, Pepper, Steiner, West, and other special authors on this subject. See also an excellent chapter in Churchill's "Diseases of Woman," pp. 57—64). Mr. Kinder Wood, of Manchester, showed that a severe form sometimes prevails as an epidemic, and terminates in *noma*, to be mentioned presently. ["Med.

Chir. Transact.," vol. vii. p. 84.] The *history* of these cases is all important. Any discharge that was noticed *immediately* after the alleged rape is probably of *older date.* In any case some day or two, or at the very least twenty-four hours is required for the formation of purulent discharges. In a medico-legal point of view, Dr. Churchill very justly remarks, that no importance is to be attached to statements elicited from a child by threats. It is only when the child makes the first complaint that her evidence is likely to be valuable. In too many cases the mother or friends seeing a discharge, rush to the conclusion that it is due to violence, and bully the child into accusing some lodger or acquaintance. It is to be feared that too many of these charges are made merely to extort money. In a case known to one of the authors, the accused was driving the magistrate, who tried the case, at the very time alleged by the prosecution as the time of the crime. This alibi was also confirmed by the evidence of a washerwoman, who had seen stains on the child's clothing for some days. *Noma,* a destructive and gangrenous form of ulceration of the pudendum, not unlike the disease of the same name in the mouth, may also be mistaken by a careless observer for the results of attempted violation. On this point consult Dr. Taylor (*loc. cit.* p. 445). Remember, however, that a ravisher may select, unknowingly, a child already diseased as his victim. This was probably the case with *Amos Greenwood* (Liverpool Winter Assizes, 1857), whom Sir W. Wilde thought unjustly accused. It was, however, proved to the satisfaction of the Court, and the barristers present, that he had inflicted violence on the sexual organs. [Acute eczema could only be mistaken by a very ignorant medical witness.]

Rape during Sleep.—Anæsthetics, Narcotics, and the Question of Resistance.

Most of our previous remarks have applied to children. In older females, unless spermatozoa be detected, the evidence, from a medical point of view, is often far less satisfactory, because, especially in the case of married women, or those who have had sexual intercourse, there are often no signs at all of injury on the pudenda. You must, of course, examine for marks of other injuries. But the question is often raised, "Can a female, after puberty, be violated without consent?" In the case of strong young women, we think there can be no question that by movements of the thighs and trunk, they can perfectly prevent intromission of the male organ. But there may be threats of violence used to extort consent; and in our opinion the fear of death, or of brutal violence, is exceedingly liable to paralyze the muscles, and prevent effectual resistance. The Jewish law drew a just distinction between lonely places and populous cities. Very young children, and weak and aged females, may be very little capable of offering resistance.

We are of opinion that *rape during sleep* could only be possible in the case of married women, or in those habituated to sexual intercourse, or in the case of such profound sleep as would properly fall under the heading of unnatural and unhealthy somnolence or catalepsy. The Scottish judges recently decided that it was quite possible for a man to have connection with a woman whilst asleep. (Case of *Sweenie.* Irvine's "Justiciary Reports," vol. iii., p. 109; and "Edinburgh Monthly

Journal," December, 1862, p. 570.) Magnetic trances, or the so-called mesmeric state, might possibly lead to similar unconsciousness. A woman might faint after galvanism. But the old maxim, "*Non omnes dormiunt qui clausos habent oculos,*" probably applies to many of these cases. Chloral-hydrate, opium, tobacco, chloroform, ether, and other narcotics and anæsthetics, might doubtless be applied, and have been, for criminal purposes; but we have to remark on all of these, that none of them (not even chloroform and ether) induce instantaneous insensibility; and hence all the accounts which speak of a dose being given, or a handkerchief being forcibly held to the nose, and then go on to describe *instant insensibility*, are to be considered as false, and looked upon with the gravest suspicion. *Syncope* may, of course, occur, and would, no doubt, favour the design of the seducer. But the terror and excitement of such an assault do not usually lead to this result.

"*Can pregnancy follow rape?*" is a question that must be answered in the affirmative, as there are numerous cases which prove this. [See Taylor, *loc. cit.* p. 463; also Tardieu, *loc. cit.*]

Are the symptoms in the [*supposed*] *victim, or in the accused, due to syphilis, or gonorrhœa?* You can only answer this question by a thorough knowledge of these two diseases. For non-medical readers, however, we deem it right to state:—(1) That both diseases have a period of *incubation* or latency. In *gonorrhœa*, this varies from some hours to three or four days or more. In *syphilis*, the period is still longer, varying from ten, to forty-four, or more days. [Bäumler on Syphilis, "Ziemssen's Handbuch der Speciellen Pathologie und Therapie," p. 73, &c. See also the medical evidence in *Davy* v. *Simpson*, 1875.] The *existence of secondary and tertiary symptoms soon after the alleged rape*, or of *profuse discharge* a few hours after, would be against the supposition that the disease had been recently communicated.

Summary of Medico-Legal Facts and Opinions.

1. All cases in which the charge is made some weeks or months after the alleged crime are doubtful; and medical evidence can seldom throw much light on the question.
2. The discovery of spermatozoa on the clothes or person of the victim, and of recent signs of violence, and of defloration, are the only reliable *medical* proofs of the crime.
3. The simultaneous existence of disease in prisoner and complainant may be corroborative proofs, provided the dates agree.
4. The effects of various diseases may simulate violence.
5. The crime is possible in deep sleep (of married women, or those used to sexual intercourse), and under narcotics, or anæsthetics, or during syncope, or with consent induced by terror. Great caution is, however, necessary in deciding such cases.
6. Severe, and even fatal, injuries may be inflicted by the male organ.
7. There are, however, no medical proofs which show that *only* the male organ has been used.
8. Pregnancy may follow rape.
9. Many of the charges are false, probably nine out of ten.
10. A medical witness, in forming his report, should keep *facts* and opinions separate.

On the usual Defence in cases of Accusation of Rape.

The medical witness ought to be aware of the line of defence likely to be adopted by or for the accused, in cases of this kind. The usual arguments are

1. That the accused is *impotent*, or incapable of committing the alleged crime. This may be really true in regard to very old, or very young males thus accused, or in the case of those labouring under certain diseases. [Diabetes—some forms of paralysis, &c.] We must refer you to our general remarks on Impotence and Sterility, p. 679, &c., for the general principles. If a young and vigorous girl alleges that she was forcibly raped by an aged and feeble man, her evidence ought clearly to be received with great caution. The authors were consulted in a case of this kind, in which a domestic alleged that her master, who was very advanced in life, and so paralysed as to be unable to move from a chair without assistance, had forcibly violated her—she being a strong and healthy young adult. We need scarcely say what our answer was. On the other hand, real criminals, with perfectly healthy and well-formed genitals, will frequently allege that they are impotent, and often assert that their sexual organs are abnormally small when this is not the case. *See* the illustrative cases at the end.

2. The accused will sometimes assert that, although not impotent, or incapable towards others, yet they could not have committed the crime, because there is a great disproportion of size between their sexual organs and that of the child concerning whom they are accused. In a medico-legal point of view, such a defence is worthless—because, although the disproportion may prevent complete or perfect intercourse, it does not prevent the attempt, which is now justly held to be the essence of the crime. Again, it is precisely because of this disproportion that such frightful injuries are often inflicted—either by the male organ, or by the hands—or some other instrument being used to dilate or widen the female parts.

3. An *alibi*, or evidence of being elsewhere, if substantiated, is, of course, a substantial defence quoad the particular person accused. It cannot, however, weaken medical evidence of the special signs of recent and forcible defloration. At most, it can only prove that the particular person accused did not commit the crime. In those cases, however, in which the medical evidence points to disease, an alibi must, of necessity, greatly strengthen such evidence.

4. It may be proved that the alleged crime was sworn to as having been perpetrated in some place, or at some time, in which it was only necessary for an outcry to be made in order to secure assistance against the supposed ravisher. The Jewish law, as we have shown, fully recognised this, and medical evidence is scarcely admissible here, except as to the distance at which sounds may be heard (*see* page 640). You might also be asked whether fright, syncope, or narcotics might prevent such an outcry, and your answer must clearly be, that this is possible.

5. Evidence as to *character*, as regards both accuser and accused, is rather of a legal than a medical nature.

6. Evidence as to *sanity*, though almost purely a medical question, is not often sought, since a *criminal lunatic* is liable to be detained during

Her Majesty's pleasure—and barristers are therefore reluctant to raise this defence.

7. We have before stated, that the question as to *self*-infliction of injuries in the pudenda, or on other parts of the body of the female, may be raised. The answer to this will depend not only on the nature and site of the injuries, but on the age of the female—for example in *Hume's* case, an infant of eleven months would never have inflicted such severe, and as it proved, fatal injuries. Indeed *could* not.

Illustrative Cases.

It is almost impossible to do justice to this subject without quoting a few cases. You will find a good many in Beck and Taylor, also in Casper, Devergie, and Tardieu. Our limits, however, and the general plan of this work, only allow us to give the following :—

CASE I.—*Infantile Leucorrhœa. Accusation of Rape. Acquittal of Accused, who established an alibi.*

A girl, aged thirteen, was brought, in 1864, to one of the authors, with the statement that ten days previously a cabman had forcibly violated her in his cab. The child was rather under the average size, weak, thin, and cachectic. She appeared rather weak-minded. There were no signs of puberty. All her clothes had been washed. The clitoris was large. The pudenda, buttocks, and thighs were filthy, stained with ordure, and discharge, and excoriated. There was muco-purulent discharge from the vulva and vagina. Hymen still present, annular, but had a slight laceration on left side. The fourchette had also been lacerated at some time. The edges of the torn parts were callous. The colour of the parts was a dirty pale-red. The discharge was first noticed, and soreness complained of by the child ten days before—but it was only after the parents had asked her all sorts of questions, and threatened to beat her, that she spoke of the cabman. She pointed out a man with a white horse, who was known to her parents. It was, however, clearly proved that the man was miles away from the place at the time the supposed rape was said to be committed. In this case there had very probably been attempts at sexual intercourse at some time or other—but not at the date mentioned.

CASE II.—*Rape of an adult female by a single man, without accomplices.*

This case will be found in Casper, vol. iii., p. 311. A man persuaded a girl, aged twenty-five, to accompany him to a public garden—in the dark—threw her down—after trying in vain to accomplish his purpose against a tree—and then violated her. The police testified that the ground was frozen hard, so that the fall probably occasioned considerable pain. The man, when found, was still in a condition of actual satyriasis. On examination of the woman, nine days after, the entrance to the vagina was still reddened and dilated, and painful when touched. The hymen was completely torn and bright red : carunculæ still slightly swollen, were visible ; the frænulum or fourchette still existed.

CASE III.—*Alleged rape. Virgin condition of genitals found on examination.*

This is Case LIX. of Casper. On examining the girl, aged fourteen, who complained, he "found the genital organs perfectly uninjured, and in their virgin state; the examination gave no pain, the entrance to the vagina was narrow, the hymen quite entire, and without a trace of laceration, either recent or cicatrised." A Dr. E—— had certified that "there were two small lacerations in the hymen!" There was no trace of seminal stains or spermatozoa on the girl's clothes.

CASE IV.—Case of *Mary Ashford* (Warwick Assizes, August, 1817).

This case is remarkable as being the last in which "wager of battle," allowed by the old English law, was claimed by the prisoner, Abraham Thornton. The Act permitting this was abolished in 1819, as the prisoner, who was doubtless guilty of the murder, escaped harmless, because the brother of the murdered girl was a mere boy. The jury had acquitted him on the faith of an alibi, which was probably false. The dead body of Mary Ashford was found in a pool of water, with duck-weed and water in her stomach. The genital organs were lacerated, and covered with coagulated blood. She was menstruating at the time. Thornton's shirt and pantaloons were also bloody. He confessed the connection, but denied that it was forced, alleging the consent of Ashford. [*See* Beck, *loc. cit.*, p. 93, and Cummin's Lectures, "Medical Gazette," xxi., p. 386.] In this case there was an evident impression of a human figure on the grass, and coagulated blood in the middle of the impression.

CASE V.—*Attempted rape, suicide of the victim, marks of violence on her body, and that of the accused.*

This is Case XXIX. of Tardieu (*loc. cit.*, p. 155.) The woman committed suicide by throwing herself out of window. Besides injuries due to the fall, there were scratches on the nose, and evident marks of nails in the front of the neck and throat. There were bruises on the arms and legs of doubtful origin, with marks of nails on the lower part of the belly; and inside the thighs were bruises like finger marks. Examination showed that the hymen had long been destroyed. The accused had bruises on his forearm, especially the left, resembling the forcible pressure of resisting hands. He admitted that he had "touched" the deceased, and partially introduced the penis. He denied violence.

CASE VI.—*Rape, with complete defloration. Marks of fingers after three weeks.*

[Tardieu's 31st case, *loc. cit.*, p. 171.] The victim was aged 17½ years. The hymen was torn almost to the perineum. Three weeks after there were five finger-like bruises on the right forearm, and two such on the outside and inside of the left arm, just above the wrist.

CASE VII.—*Violation, followed by Pregnancy, at the age of* 12½ *years.*

This is Tardieu's 35th case. The girl became a mother at a trifle over thirteen years. For other cases of pregnancy following rape, *see* Tardieu, cases 33, 34, 23, and several cases in Taylor (*loc. cit.* p. 463).

Rape on adult females, habituated to sexual intercourse. Absence of all signs of violence.

All the authors quoted give numerous instances of this—doubtless due either to partial consent, or to the woman being so held by accomplices that the act of coitus became easy to accomplish—or to the crime having been done whilst the woman was unconscious.

Rape of males by females.

Casper, Tardieu, and other foreign writers give instances of this, followed by conviction and punishment. Although, as Dr. Taylor says, there can be no doubt of the crime being often committed by grown-up women on small boys, yet it appears to be unknown in the English Courts of law.

CHAPTER XXVI.

The induction of premature labour—Abortion from disease or accident—Criminal abortion—Medico-legal proofs of the crime—Infanticide—Proofs of live birth—Docimasia pulmonum—Concealment of birth, &c.—Legitimacy and superfetation.

We have elsewhere stated that our laws do not recognize formally, the induction of premature labour. The distinction has, however, been made over and over again, by the judges engaged in trying prisoners for criminal abortion. It is sufficient to quote the names of Lord Denman, Baron Bramwell, and the Lord Chief Justice [Cockburn]. We ourselves in the case of *Simpson* v. *Davey* [*see* page 720], heard the latter judge explain to the jury, that medical men were morally, if not legally, justified in inducing premature labour with the object of saving the life of the mother, or child, or both. The first general medical agreement upon this question appears to have been about the year 1756, in which year, Dr. Kelly informed Dr. Denman that "there was a consultation of the most eminent men at that time in London, to consider the *moral rectitude* of, and the advantages which might be expected from this practice, which met with their general approbation." [Denman's "Introduction to Midwifery," p. 318, 7th ed.; *see* also Churchill's "Manual of Midwifery," and "Researches on Operative Midwifery," and a paper by Dr. Barnes in the Obstetrical Society's "Transactions," vol. iii., 1862.] The only objections which can now reasonably be made against the practice as now recognised by British obstetricians are religious ones, advanced by Catholics, against destroying infant life, before the possibility of baptism, other than in utero. Even these objections do not lie against the operation at a time when the infant is *viable*, which is what is generally meant by the induction of premature labour. They only pertain to those cases in which the fœtus is not viable, and when the operation is intended as a substitute for Cæsarian section, in cases of extreme deformity of the pelvis. For an able summary of the views of both sides, we refer to Dr. Churchill's chapter on "Obstetric Morality," in the Appendix to his work on "Midwifery." They do not affect the *legal* bearings of this question. The cases in which it is recommended to induce premature labour are, (1). Cases of more or less extreme narrowing of the pelvic brim [*see* the normal diameters of the pelvis, and scheme of abnormal ditto, at pages 642 and 718]. In those cases of deformity, where neither version nor forceps at full term can succeed, a child may often be born with perfect safety to the mother, and sometimes alive, at seven months. As regards the statistics of such cases, Velpeau collected 161, of which eight mothers died, though only three were supposed to die from the operation. Figuera collected 280 cases with six deaths of mothers. Dr. Hoffman found out 524 cases, in thirty-four of which the operation had been repeated three, four, or more times. In 373 of these, 250 children were born alive, and 123 dead [*see* Churchill, *loc. cit.*]. (2). In some cases of obstinate vomiting, or of pregnancy complicated with diseases of the uterus or other organs, (such as cancer, fibrous tumour, &c.), the same operation is indicated. (3). In cases of placenta prævia or other severe hæmorrhages. (4). In cases of rupture of the uterus. (5). In cases of narrowing of the soft passages, cicatrices of the vagina, &c. It is chiefly in the first class of cases that the operation is to be defended. M. Figuera gives the following table of the diameters of the fœtal head at different ages.

Age of Fœtus.	Bi-parietal diameter.	Occipito-frontal diameter.	Occipito-bregmatic diameter.
7th month.	2 inches 9 lines.	3 inches 8 lines.	2 inches 10 lines.
7½ „	3 „	3 „ 9 „	3 „
8th „	3 „ 1 „	3 „ 10 „	3 „ 1 „
8½ „	3 „ 2 „	4 „	3 „ 2 „
9th „	3 „ 4 „	4 „	3 „ 4 „

Ritgen gives a table, founded on the measurements of the pelvis. He says that labour may be induced at the—

29th	week, when the conjugate diameter of the pelvis is	2 inches	7 lines.
30th	„ „ „	2 „	8 „
31st	„ „ „	2 „	9 „
35th	„ „ „	2 „	10 „
36th	„ „ „	2 „	11 „
37th	„ „ „	3 „	

These tables are not quite identical, but the child's head varies somewhat, and is compressible to some extent [*see* Churchill, *loc. cit.*].

The operation has been performed in a great variety of ways: it will be sufficient to mention the chief of these, as the principles involved are in all cases similar, viz.:—to set up uterine action, in some way which shall be as safe as possible for the mother, and in most cases for the child also. It is not for us to decide here on their relative merits. The chief methods then of inducing premature labour are:—(1). Puncturing the amniotic sac or membranes. (2). Ergot of rye, and other ecbolics. We shall return to these when speaking of criminal abortion. (3). Separating the membranes from the lower portion of the uterus. (4). Passing a flexible catheter between the membranes and the uterus, *i.e.*, within the womb, and retaining it there some hours. (5). Mechanical dilatation of the cervix, by instruments, by sponge or laminaria tents, or by india-rubber bags filled with warm water or air [Barnes or Keiller's *dilators*]. A calf's bladder has been used for a similar purpose. (6). Galvanism. (7). Irritation of the mammary glands or breasts. (8). Injection of carbonic acid into the uterus. Scanzoni relates a fatal case, so do Bernard and others. (9). Injections of warm or cold water, or of both alternately, into vagina, uterus, or both; even large enemata, or the introduction of plugs into the rectum or vagina would probably do it. It is possible by some of these methods, particularly the use of dilators for the vagina and uterus, not only to bring on labour, but also to time the birth of the child, and the completion of labour within a few minutes, we had almost said seconds. In some cases, the forceps or version, or even instruments for destroying the child might have to be used to complete the delivery.

As *miscarriage* and *abortion* are used to signify the expulsion of the ovum or child before it is viable, and *premature labour* to signify the expulsion of the child after it is viable, we must now consider the question of *infant viability*. *Ovum*, signifying an egg, is a term which might be applied so long as the membranes are unbroken. It is, however, generally used to signify an early stage of infant life, before quickening. *Fœtus* is again used to signify the fruit of the womb, from the period of quickening until its birth. In the later stages, however, from six to nine months, it is more usual to speak of the *child*. Accoucheurs also use the word *embryo*, as when they speak of embryulcia, meaning the destruction of the embryo, as in craniotomy, &c. The earliest ova or eggs which have been examined from the human female, after abortion, are those of some twelve or fourteen days. The size of such an ovum is about that of an ordinary pea, or little over a quarter of an inch in diameter. The surface is shaggy from the tufts of the *chorion*, one of the *membranes* of the fœtus—these tufts afterwards form the placenta. The figure [from Dr. Carpenter] shows a human ovum entire, at the eighth week, sixteen lines in length, not reckoning the tufts.

FIG. 96.

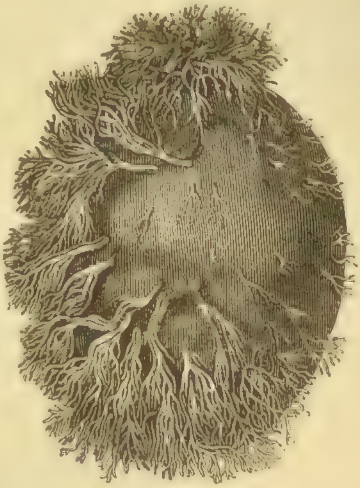
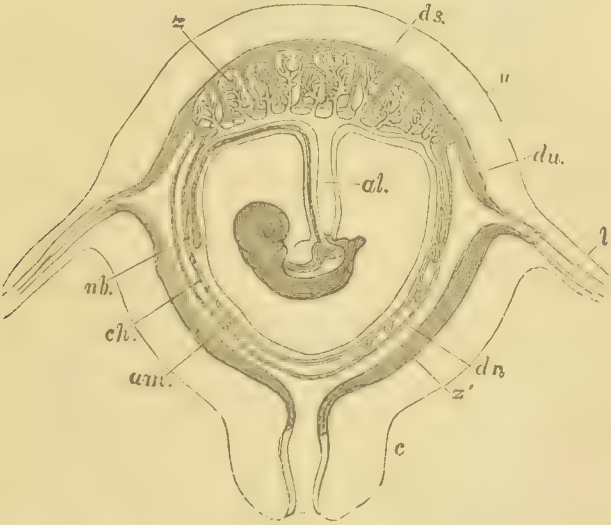
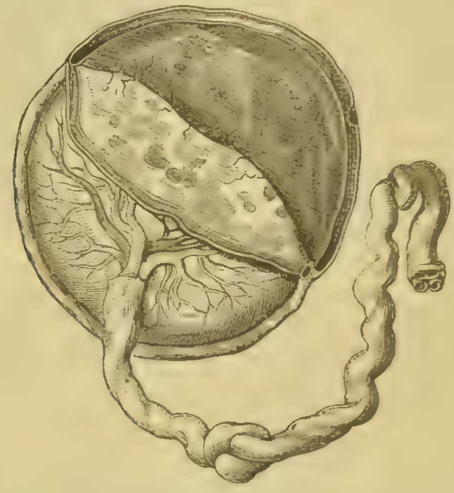


FIG. 97.



The surface of the chorion partly smooth, and partly rendered shaggy by the growth of tufts. We have already given [pp. 644 to 647] a table of measurements of the fœtus, at different ages, so that we need not enlarge here upon this point. The next figure shows the relation of the fœtus to the uterus after the placenta has formed. It also explains many of the terms used in speaking of the embryo and its development. The fœtus or young child occupies the centre—the large size of its head at once attracts our attention. *c* is the *cervix uteri*, or neck of the womb ; *du* is the *decidua uterina ; dr* the *decidua reflexa ; ds* the *decidua serotina ; z* are the *fœtal tufts* or *villi*, or blood vessels intended to nourish the fœtus ; *ch* is the *chorion ; am* the *amnion ; al* the *allantois ; nb* is the *umbilical vesicle ; z′* are *fœtal tufts*, supposed to be superfluous in the human embryo [after Longet from Huxley]. The *placenta* begins to be formed at a very early period, but is distinctly visible about the third month. Its structure and connections with the fœtus and uterus will be understood from the figures in the text. Fig. 98 shows the placenta with the *umbilical cord* or *funis* attached. The free cut end of the latter shows the two arteries and one vein, of which the funis is chiefly composed. The figure shows one of those knots which often form spontaneously. The next figure [No. 99] shows a section of the human placenta and the uterine wall. It is sufficiently explained by the lettering. The larger openings in the wall of the uterus are the so-called *uterine sinuses.* Whilst the fœtus is in utero it breathes in the physiological sense, in other words, it gets its blood aërated by means of the interchange which takes place between its blood and that of the mother, by means, at first, of the tufts of the chorion, and afterwards by those of the placenta, which are really the development of the former. Before it can lead an independent life of its own, certain changes must take place in its lungs and heart, and its vascular system must be fairly developed. These changes will be better understood when we speak of the proofs of live birth. At present, the point we have to consider is this. For a child to be *viable*, in other words, capable of living after its birth, it must have attained a certain degree of development, as well as growth. Intra-uterine life in the mammalia is, in fact, a species of hatching. Just as the egg of a fowl requires

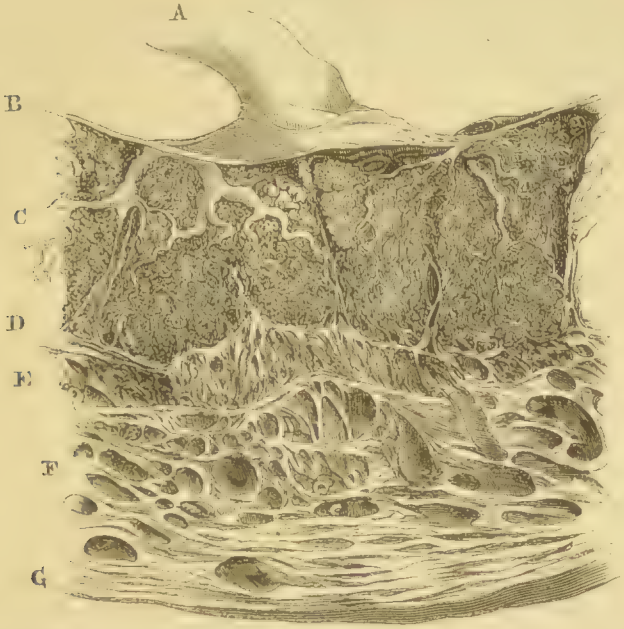
FIG. 98.



UMBILICAL CORD, AND OUTER SURFACE OF PLACENTA. The Chorion and Amnion raised from over-portion of Placenta.

warmth to hatch the young chick, so warmth is required by the human ovum, to hatch the future man [homo]. Hence a child born prematurely, requires more warmth than an infant born at full time. How soon a child is viable is not a matter of theory, but of practice or experience. We have already (pages 701, 702) recorded some cases of infants born at very early periods of utero-gestation. Seven months' children, and those born at eight months are sufficiently common. The cases quoted above were one of Dr. Montgomery's at Plymouth (200 days), living till thirteen years. The famous *Jardine* case, 5 months and 21 days [174 days]. One by Dr. Outrepont of Bamberg, born at 6 months [200 days], living till he was 11 years old. Another Scotch case [*Elder* of Whitethorn's child], at five months, is, perhaps, more doubtful. So is Dr. Rodman's case. Mr. Baber's case, born at 6½ months, weighed only 1 lb. 13 oz., 50 days after birth. It was *then* only 14 inches long, and the head measured 10 × 9·1 inches. Dr. Barker gives a case of a female born at 158 days (5½ months). She weighed 1 lb., measured 11 inches, and could not suck properly for a month, did not walk till 19 months old, and was healthy, though small at 3½ years of age. The French law allows children born at 6 calendar months (180 days) to be viable and legitimate. The Scotch law allows 6 lunar months, or 168 days. The Parliament of Paris, in Cardinal Richelieu's case, decided "that the infant at 5 months possessed that capability of living to the ordinary period of human existence, which the law of France required for establishing its title and inheritance." The general characters of immature children are given at page 702. Dr. Guy gives the following additional cases. Mr. Thomson's [quoted by Beck] in which a 5 month's infant, as was

FIG. 99.



A, Umbilical cord; B, Chorion; C, Fœtal villi separated by processes of, D, the cavernous decidua; E, F, G, Wall of uterus. [After Ecker. 30th week of pregnancy.]

supposed, lived 3½ hours. Christison's [evidence in the Jardine case] one of 167 days, lived 8½ hours. Bucholtz [" Beitrage," ii., 104], one of 189 days, lived 2 days after birth]. Kopp's [" Jahrbuch," iii., 128] at 182 days, lived 4½ days. Fleischmann's [" Henke's Zeitschrift," vi., 12], at 168 days, survived 8 days. Belloc and Capuron mention instances of children surviving at 6 and 6½ months. Some other cases are given by Beck [*loc. cit.*, pp. 190-193], and Taylor [*loc. cit.* 250, etc.] As regards the English law, this question of *viability* does not arise either with regard to inheritance [Tenancy by courtesy] nor in infanticide—nor in criminal abortion. It is only raised, as a sub-issue in cases of disputed *legitimacy*. Although this subject will be briefly considered again, one or two of Dr. Taylor's cases are remarkable enough to deserve quotation. Thus a case is quoted by him from the " British and Foreign Medico-Chirurgical Review " [vol. ii., p. 236], in which a child was born, living as early as the 4th month of gestation. Of another, in which M. Maisonneuve saw an infant who had been born at 4½ months in the membranes. On opening these, 2½ hours after the birth, he found it living, and breathing. It died 6 hours after. Carter (of Richmond) saw a 5 months' fœtus breathe, and heard it cry. Other cases of similar early live births by Davies of Hertford, Smythe, Routh, Rittel, Annan, and others are mentioned by the same authority. (*See* also Dr. Montgomery, *loc. cit.*) p. 513, etc.) The practical conclusions are as follows :—

1. Children born at seven months, eight months, and intermediate periods up to term, not only may live, but constantly do so.
2. Life is also possible, though less probable, at six to seven months. A few survive.
3. Children have been born alive as early as four to five months. At the latter age, or a few days more, one or two have survived.
4. Although from the first moment of impregnation the ovum is *alive*, yet previous to the fifth month there is no possibility (so far as we know) of their being reared, and before six or seven months, it is very improbable.

Having thus cleared the ground of some difficulties, we proceed to tabulate the principal causes of what we may call *natural* abortion in contradistinction to *criminal* abortion. These are well stated by Dr. Barnes in his work on " Obstetric Operations," [p. 385, 1st ed.] in the following table :—

A. *Maternal Causes of Abortion.*

I. Poisons circulating in the mother's blood.	*a.* Introduced from without : as fevers, syphilis, various gases, lead, copper, &c. *β.* Products of morbid action : as jaundice, albuminuria, carbonic acid from asphyxia, and in the moribund.
II. Diseases degrading the mother's blood.	Anæmia, obstinate vomiting, over lactation.
III. Diseases disturbing the circulation dynamically (mechanically) : as liver, heart, and lung disease.	

IV. Causes acting through the nervous system.
  α. Some nervous diseases : as chorea, &c.
  β. Mental shock.
  γ. Diversion or exhaustion of nerve force : as from obstinate vomiting.

V. Local disease.
  α. Uterine disease : as fibroid tumours [polypi], inflammation, hypertrophy, etc., of uterine mucous membrane.
  β. Mechanical anomalies : as retroversion, pressure of tumours external to uterus, &c.

VI. Climacteric abortion.

VII. Abortion artificially induced.

B. *The Fœtal Causes of Abortion.*

I. Diseases of the *membranes* of the ovum, primary, or secondary upon diseases of the maternal structures or blood, as—

Fatty degeneration of the chorion or placenta.
Hydatidiform ,, ,,
Inflammation, Congestion ,, ,,
Apoplexy ,, ,,
Fibrous deposits ,, ,,

II. Diseases of the embryo itself—

α. Malformation.
β. Inflammation of serous membranes.
γ. Diseases of nervous system.
δ. ,, kidney, liver, etc.
ε. Mechanical, as from torsion of the cord or funis.

In short, anything causing the *death* of the embryo. The causes are often complicated, arising partly from the maternal, partly from the fœtal side; and it is often difficult to unravel these, or to discover the efficient cause. Abortion has a great tendency to become a habit. Whether from disease, or produced artificially, there can be no doubt that this event places the previously gravid female in considerable danger. In other words, the earlier the period at which the uterus is emptied the greater, *cœteris paribus*, are the risks. We need not seek far for some of the causes. At or near full term, the uterus is a collection of powerful muscles, able to contract firmly upon its contents, and when these are expelled, upon its gaping and bleeding vessels. At earlier periods, its powers of contraction are far more limited, and hence the risks of hæmorrhage are almost infinitely greater. But hæmorrhage is not the only risk, the gaping sinuses will absorb all sorts of gaseous (volatile) liquid, and solid poisons. Hence the woman is exposed to zymotic and septic diseases [fevers, and pyæmia, puerperal peritonitis, etc.]

Hence we strongly urge upon young medical men, and indeed on medical men of any age,—

1. Not to induce premature labour or abortion without the fullest consideration of all the circumstances of the case.

2. If possible to get a *consultation* with some other and experienced practitioner.

3. In any case to have the full consent in writing, if possible, of the husband or guardian.

We have known this operation performed in cases of chorea, heart disease, phthisis, and the like, when the patient, instead of being benefited, was in a far worse condition after the operation.

As regards *criminal abortion*, it is justly reckoned a *felony* in English law. The term *abortion* is, medically, usually limited to procuring the expulsion of the contents of the womb, *before the sixth month of gestation.* The law makes no such distinction of time. If a woman dies after the attempt, the crime is usually considered as murder, although the accused may not have meant to destroy life. The law was thus laid down by Baron Bramwell in Stadtmühler's case, Liverpool Winter Assizes, 1858 :—" If a man, for an unlawful purpose, used a dangerous instrument, or medicine, or other means, and thereby death ensued, that was murder, although he might not have intended to cause death, although the person dead might have consented to the act which terminated in death, and although possibly he might very much regret the termination that had taken place contrary to his hopes and expectations. This was wilful murder. The learned counsel for the defence had thrown on the judge the task of saying whether the case could be reduced to manslaughter. There was such a possibility, but to adopt it would, he thought, be to run counter to the evidence given. If the jury should be of opinion that the prisoner used the instrument not with any intention to destroy life, and that the instrument was not a dangerous one, though he used it for an unlawful purpose, that would reduce the crime to manslaughter. He really did not think that they could come to any other conclusion than that the instrument was a dangerous one, if at all used. Then, if it were so used by the prisoner, the case was one of murder ; and there was nothing for the case but a verdict either of murder or of acquittal." [Taylor, *loc. cit.*, p. 181.] The legal relations of this crime have been exceedingly well put by Dr. Taylor. [*loc. cit.*, pp. 198-199, &c.]. We may, however, summarise them as follows :—

The nature of this crime, and the proofs required to establish it, have been more explicitly stated than formerly, in the statute for the consolidation of the criminal law [24 & 25 Vict. chap. 100, §§ 58 and 59]. By clause 58 (in attempts to procure abortion), it is enacted that " Every woman, *being with child*, who with intent to procure her own miscarriage, shall unlawfully administer to herself any poison, or other *noxious thing*, or shall unlawfully use any instrument, or other means whatsoever, with like intent, and whosoever, with intent to procure the miscarriage of any woman, *whether she be, or be not with child*, shall unlawfully administer, &c., shall be guilty of felony." Thus a widow woman, called *Warboy*, was convicted at the Central Criminal Court, August, 1863, as an accessory before the fact to the felonious using by one *Morgan* of a certain instrument upon herself with intent to procure miscarriage. The latter portion of clause 58 makes it immaterial so far as another person is concerned, whether the woman is, or is not with child, in accordance with the decision of the judges in *Reg.* v. *Goodhall* [1 Den. C. C. p. 187], and *Reg.* v. *Goodchild* [2 C. & K. p. 293.]

Clause 59 is to the following effect :—"Whosoever shall unlawfully supply or procure, any *poison or other noxious thing*, or *any* instrument, or *thing whatsoever*, knowing that the same is intended to be unlawfully used, or employed with intent to procure the miscarriage of any woman, whether she be or be not with child, shall be guilty of a misdemeanour, and, being convicted thereof, shall be liable, at the discretion of the Court, to be kept in penal servitude for the term of three years, or to be imprisoned for any term not exceeding two years."

The *means*, it will be seen, must be used with *intent*, &c. Dr. Taylor says a plain medical statement of the means employed is sufficient. For a discussion of the term *noxious*, see his remarks, p. 199. The chief difficulties in regard to this term seem to have been raised by the stupidity or hypercriticisms of medical witnesses themselves !

It is to be feared that criminal abortion is on the increase in England. It is fearfully prevalent in the United States, and was so formerly in France. The "Free-lovers," and other so-called religious sects of America, and some of the sexless things known as the advocates of Women's Rights in England, have at different times openly and unblushingly advocated the practice. Classical readers know how prevalent it once was in Rome :—

> "Cùm tot abortivis fœcundam Julia vulvam
> Solveret, et patruo similes effunderet offas."
> *Juvenal*, Sat. ii., l. 32, 33.

> "Sed jacet aurato vix ulla puerpera lecto.
> Tantùm artes hujus, tantùm medicamina possunt
> Quæ steriles facit, atque homines in ventre necandos
> Conducit, etc." Ibid, Sat. vi., l. 593, etc.

See also the Octavius of Felix Minucius, ch. xxx., quoted by Beck—whose chapter on the subject shows how generally prevalent the practice was amongst ancient nations till Christianity taught the sanctity of human life. In modern times our unjust laws and more unjust social customs, by making the woman bear almost all the burden of support, and the whole of the shame of illegitimate children, have tended to make some medical men look on this crime rather as a charitable action, done to shield a suffering woman, than as it really is, a foul and unnatural crime, not only against society, but against a helpless, innocent, and defenceless life—one of the most cowardly acts a man can perpetrate—since 5½ or 6 feet, and 10 or 12 stone are pitted against a few inches, and less than half a stone in weight !

The means used to procure abortion.

In general terms it may be said that all the means mentioned in page 746 to induce premature labour, have been imitated by those who wish to procure abortion, and who practice this nefarious art. Some of the means employed require special notice, and we must therefore be forgiven for some slight repetitions. It has been said, with some show of propriety, that it is a pity to *instruct* people how to perpetrate a crime. Our answer to this is simply, that the criminals, in most cases, want no instruction, and that it is absolutely necessary that not only medical men, but magistrates, and the members of the legal profession in general, should thoroughly understand all the manœuvres of these villains in order that their crimes may not go unpunished for want of being known. All the methods of procuring abortion may be classified under two or three headings, such as :—I. Violent exercise, and brutal violence, applied in a general manner. II. The use of drugs reputed to be abortifacients. III. Mechanical injuries inflicted on the uterus and its contents. We will take these *seriatim.*

I. *Violent exercise, and brutal violence employed in a general manner.* Copious general bleedings, and the repeated use of very hot and very cold baths, should perhaps be noticed here. Both these measures usually fail. Although it is almost self-evident that excessive bleeding must be injurious to the woman's health, yet Mauriceau ("Observations sur la Grossesse et l'Accouchement des Femmes," Paris, 1694, p. 18,) relates the case of two women who were safely delivered, although one had been bled forty-eight times during her pregnancy, and the other had been blooded no less than ninety times ! [Tardieu, *loc. cit.*] Other cases of similar kind are known in modern times. In such cases you would find marks of the bleeding either in the bends of the elbows, backs of the hands, or on the instep, ankle, or some other spot where there are superficial veins. Although no trace might be found of baths, the fact might be established by the evidence of witnesses. Women will often take extraordinarily long walks, roll down hill, throw themselves down stairs, or out of window, or submit to be rolled over and over, to be laced in with extreme tightness, or even to be trampled upon and kicked, on the abdomen, in order to get rid of their burden. Tardieu ("Etude Médico-légale sur l'Avortement," p. 27) mentions the following case, in which one scarcely knows whether most to pity the woman or to execrate the man (?) :—In the Assize Court of the Loire-Inférieure, it was proved that a peasant, who had seduced his servant, and wished to make her abort, mounted on a strong horse, and put the girl on the same horse, then galloped wildly hither and thither, throwing her down on the ground whilst in full gallop, and this repeatedly. Having tried this twice without success he conceived the horrible idea of applying to her stomach bread just taken from a very hot oven. This means failed like the former, and the poor victim gave birth to a living and well-formed child at term. [Brillaud-Laujardière, "De l'Avortement provoqué," Paris, 1862, p. 279.] Dr. Guibaut, in 1859, quoted the case of a young lady from Munich, living in California. Becoming pregnant, she wished to go to Munich to be delivered. In crossing the Isthmus of Panama she was subject to a railway collision. In consequence of this labour pains set in. In spite of them she embarked for Portsmouth. She had a horrible passage—with fresh accidents. In spite of these the pains subsided each time. She again embarked, but on reaching Paris, fell from the top to the bottom of the hotel stairs ! Again she was seized with pains like those of labour. She was then eight months pregnant. Next day she departed for Munich, and was not confined till some days after her arrival in that city. In one of the cases mentioned by Tardieu there was a sort of stays manufactured and worn for the purpose of abortion, which only measured sixty-two centimètres (a trifle over twenty-one inches), whilst towards the end of the sixth month the abdomen of a pregnant woman would measure from eighty to ninety-nine centimètres [$31\frac{1}{2}$ to 39 inches].

II. Amongst the *ecbolic* or *abortifacient* drugs which are used by those who wish to procure abortion we might include almost every known purgative, and almost every drug or herb which has medicinal properties. The following commonly-used substances, squills, sarsaparilla, guaiacum, *aloes,* balm [melissa], horehound [marrubium vulgare], camomile, *wormwood,* saffron, *borax,* matricaria [the common camomile], *mugwort* [artemisia vulgaris], and juniper, are considered by Tardieu, Teichmeyer, Buchner, Fodéré, and others to be perfectly harmless in this respect. We think, however, that those marked in italics may sometimes possess indirect ecbolic properties. All poisons may act thus, but to produce this effect they must be given in doses almost necessarily fatal. For the symptoms, properties, and tests of these, reference must be made to the first part of this work. Arsenic, mercury, sulphate of copper, cantharides, and other strong poisons, do not appear to have any special action on the uterus. If these were used the law would consider the crime to be one of murder. For iodide of potassium, yew, penny-royal (pulegium), and rue, there seems some evidence, though far from satisfactory, and for savine and ergot the evidence is much stronger.

We will take these seriatim. As to *iodide of potassium* [see page 87]. Tardieu quotes a case from the "Presse médicale de Marseille," 1858, Nos. 7 et 9, in which a herbalist gave a pregnant woman a mixture containing about ʒi of the iodide in about five ounces of water. She appears to have taken about half. MM. René Dumas and Fuster, professors of Montpellier, all attributed the abortion to this drug, and Tardieu seems to agree with them. This is the case quoted in the "Medical Times and Gazette," January, 29, 1859. On the other hand the authors have frequently prescribed this medicine to pregnant women in secondary and tertiary syphilis without ever seeing abortion produced. *Yew* (taxus baccata) again seems to have produced abortion in some cases, but it proved fatal also. [See Tardieu, *loc. cit.*, p. 32, for some experiments on animals.]

Savine [see page 287] has often proved abortifacient, but chiefly as it would seem from its poisonous and deadly properties. In Dr. Tidy's case a woman in the eighth month of pregnancy died without any effect on the uterus.

The *oil of rue* (*ruta graveolens*) [see page 402], and the decoction of the plant appears to have frequently proved ecbolic. Tardieu reports three cases in which the decoction produced abortion at the fourth, fifth, and sixth months of pregnancy, the women recovering. Profuse salivation, great swelling of the tongue, and in fatal cases slight inflammation of the mucous membrane of the stomach [Orfila] are the appearances recorded. [See a memoir by Dr. Helié of Nantes, on this subject, in the "Annales d'Hygiène et de Médecine légale," t. xx., p. 180, 1838]; also Horn's "Vierteljahrs," 1866, 1, 233; also a paper by Tardieu in the same Annales for 1855, 1, 403.]

Penny royal (*Mentha pulegium*) is not reckoned ecbolic by any author of repute. It is, however, frequently given with this object, and facts known to the authors make them hesitate in joining in Dr. Taylor's opinion of its innocence. In *Reg.* v. *Wallis* (Winchester Autumn Assizes, 1871), a solicitor was charged with giving Penny royal and Griffith's Mixture. Drs. Hicks, Barnes, and Tyler Smith, all denied that these drugs would produce abortion. The only preparations of iron which seem at all to have an injurious effect on pregnant women are the sulphate and the acid astringents, such as the muriated tincture in excessive doses. We believe there are no authentic instances of their procuring abortion. Very eminent obstetricians sanction the use of iron medicines in suitable cases, all through pregnancy [" Obstetrical Transactions," vol. xii., p. 33]. The ecbolic properties of *ergot* are too well known to require our dwelling upon them. In addition to the symptoms mentioned at p. 302, we may add that in case of death produced by this agent, the bladder is very likely to be found distended. Dr. Shortt ("Obstet. Trans.," vol. ix., p. 9) states that the juice of bamboo leaves (*Bambusa arundinacea*), that of the milk-hedge, *Euphorbia tirucalli*, of other kinds of Euphorbia, and *Calotropis gigantea*, and the *Plumbago Zeylanicum* or chittra-moolum, are often used in India for this purpose. That many of the Euphorbiaciæ are very poisonous is well-known. Still there is reason to believe that nearly all these medicines are aided by mechanical means by the natives of India. Both Dr. Shortt and Dr. Norman Cheevers agree that the crime is fearfully prevalent in British India. During the years 1863-4, 306 such cases were reported in the Madras Presidency. 150 offenders were apprehended, and 119 of them convicted. In America, an extract of cotton-wood is used for similar purposes. *Actea racemosa* and *Digitalis* are reported to be abortifacients.

III. *A variety of instruments and mechanical means have been used to procure abortion.* A guarded stilette [or trocar and cannula] is the safest, as pointed sticks and wooden skewers are perhaps the simplest. It scarcely seems necessary to dwell upon this subject, except to remark that in cases of this kind there will frequently be traces of violence found, on the ovum or fœtus, and in the uterus, or other organs of the woman. Most frightful injuries have been inflicted by these means in the hands of ignorant or rash manipulators. And the death of the woman is by no means an uncommon event. One or two of the illustrative cases will show the lesions we may expect to find. Syringes, and long tubes attached to reservoirs of water are somewhat favourite means, as tolerably safe, and leaving no marks except those common to all cases of abortion. The use of sponge-tents, laminaria-tents, and pessaries of various kinds is also not very uncommon. Galvanism, whilst it sometimes succeeds, has sometimes entirely failed. A long knitting-needle has been used. The authors have seen steel claws intended to be worn on the fingers, so as (it is presumed) to penetrate the membranes, or perhaps so to tear the embryo as to insure its death. The human hand alone has sometimes been the instrument, and horrible as it may seem, has been used with such violence as even to drag away the intestines. Hureau de Villeneuve mentions a singular instrument used by the Chinese [" Thèses de Paris," 1863, p. 28], which is best described in his own words [we quote from Tardieu, *loc. cit.*, p. 54]:—

" Je ne puis manquer de décrire un instrument nommé *hérisson*, employé par la lubricité des maris, et dont l'usage amène les plus déplorables résultats, car il est une cause très-fréquente d'avortement. *Herinaceus* pennæ anserinæ breviore barba confectus est. Hæc barba pennæ caule evulsa, in annulus barbillas hirsutas extrinsecus præbenteis volvitur. Annulo clauso, fila xylina argento texta singulam barbillam ab aliis separant. Instrumentum tunc simile est millo aut collari clavis erectis munito. Hic annulus hirsutus in sulco, qui glandem et præputium interjacet, inseretur. Frictiones per coitum productæ magnum mucosæ membranæ vaginalis turgorem, ac simul hujus cuniculi coarctationem tam maritis salacibus quæritatam afferunt. D'après les conseils d'hygiène donnés aux jeunes époux, cet instrument ne doit pas être employé lorsque la femme est enceinte, car la turgescence de la muqueuse amène fréquemment des hémorrhagies nuisibles au produit de la conception. Mais, contrairement à ce singulier avis, ce moyen est frequemment employé pour produire l'avortement dans un but coupable."

The *uterine sound* has been known to cause abortion, when used in ignorance of pregnancy. Young medical men should be careful never to use the uterine sound without first ascertaining that the woman is not pregnant. Dr. Taylor also cautions against the use of the *speculum* in women who are enciente. In *Reg.* v. *Griffin and Venn* (Exeter Lent Assizes, 1854), the accused *Venn*, a surgeon, was charged with feloniously using an instrument with the intent to procure the miscarriage of the prosecutrix. The defence was a singular one, namely, that Venn had used a speculum, once in a coppice, and once in a field, to ascertain if the woman were pregnant or not. Though acquitted, Dr. Taylor justly remarks, "that medical practitioners, in the lawful exercise of their profession, do not commonly use a speculum in open fields, &c., for the purpose named, and it is a well-known fact that a speculum is not required for determining the question of pregnancy at all. This case conveys a serious caution to members of the medical profession." We think, however, that the speculum might be cautiously used without any fear of abortion.

Duties of Medical Experts in Cases of Suspected Abortion.

I. You may have to examine either the living woman, or the body of a dead one. Unless examination be made within a few days, or at furthest, two or three weeks, it may be difficult to find any proofs of delivery at all. [See pages 695 to 711, for the signs of pregnancy and of recent delivery in the dead and living.] At very early periods of utero-gestation all the signs, even in the dead body, except perhaps, the finding of corpora lutea, or of a corpus luteum, will be very slight. Dr. Shortt mentions in the living—"A relaxed condition of the vulva and passages, patulousness of the os uteri, and in the early stage the presence of the lochial secretion, and of a white mucous secretion in later cases, with that characteristic acid smell common to women in the puerperal state. The distension of the breasts, flow of milk on pressure, or the fulness and knotty feeling in them for a short time after, are also observable; whilst the general anæmic appearance and sunken eyes will be noticed by the observant physician, notwithstanding the darkness of complexion of the patient [he is speaking of Hindoos]. There was also that peculiar excitement of the pulse, with dryness of skin, invariably present in such cases. In multiparous women the womb was found more patulous, resembling a loose, flabby bag, and the neck was not discernible; but in primiparæ the os, although patulous to a small extent, still had the neck protuberant."* A speculum will be needed to see the lacerations in the os uteri; and they may be felt by the finger of the examiner. *In making a post-mortem, be very careful how you remove and lay open the uterus,* as counsel or opposing medical witnesses may suggest that you yourself produced the wound. The specimen should refute such a charge. *Make clear notes, with measurements, at the time.* It is not always possible to distinguish the results of violence from natural and spontaneous ruptures. But it is generally easy to do so in the dead subject. For the characters of natural or spontaneous ruptures of the uterus, see the chapter on that subject in Barnes' "Obstetric Operations," 2nd edit. pp. 320—375. Peritonitis, when the result of violence, is generally more localized than when it is, so to speak, spontaneous in puerperal cases at term. The *marks* for which you will look, especially in the dead body, are those of *punctures, lacerations,* and *incisions* in the uterus and contiguous organs. These, particularly the punctures, are often multiple. "He stabbed me three or four times," is a usual remark of the victim. It is usually not difficult to distinguish wounds made before death, because these will have cicatrized, or be coated with lymph, or pus, or blood. [See the Chapter on Wounds.] The history of the case will sometimes help us. In rupture of the uterus when it occurs spontaneously, there is usually a sudden cessation of pains. Artificial injuries, on the other hand, bring on pains.

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* Some of these symptoms may be simulated by menstruation. See remarks by Dr. Taylor, *loc. cit.*

II. You may have to report on substances expelled from the uterus, and on stains on bedding, and articles of wearing apparel.

Under the heading of *Concealment of Birth,* we shall mention some of the conditions likely to be confounded with pregnancy and its products. The sudden rupture of an ovarian cyst, hydatids of the uterus, moles, fibroids, and some other conditions, can only be mentioned here. Attention to the characters of the ovum, given at pp. 644 and 747, will save you from mistaking blood-clots, and the like, from a fœtus. It does not seem possible to distinguish the *liquor amnii* (commonly called "*the waters*"), from other weak solutions of albumen. [See "Annales d'Hygiène," &c., 1852, 2, p. 414; Ibid. 1856, 1, p. 156; and Tardieu, *loc. cit.*, p. 90.] Its odour is usually spermatic, its colour of a lemon-yellow, or slightly greenish, rarely brown, or red from admixture of blood. It generally deposits on standing a cheesy, yellowish substance, occasionally of a darker vermilion tint. It is alkaline, contains chlorides, and its albumen varies with the period of gestation from 10·77 per cent. at the fourth month, to 7·67 per cent. at the fifth month, 6·67 at the sixth month, and only 0·82 at the ninth month. The specific gravity is about 1008, but varies considerably. At early periods of gestation it contains sugar. At full term many observers have found urea. Scherer gives the following analyses:—

	At 5 Months.	At Term.
Water	975·84	991·474.
Solids	24·16	8·526.
Albumen and Mucus .	7·67	0·82.
Extractives . .	7·24	0·60.
Salts	9·25	7·06.

The stains of this substance slightly stiffen linen, &c. Robin and Tardieu ("Annales d'Hygiène," &c., 2me série, t. xiii., p. 434, Paris, 1860) show that *fœtal hairs* may sometimes be found on cloths thus stained, along with much pavement epithelium, having granular nuclei.

The *lochial* discharges, or green waters, or cleansings, are sure to contain blood, and the remains of decidua, along with vaginal epithelium. They have an odour "sui generis."

III. You may have to report on instruments found in the possession of the accused, and on drugs, supposed to be the means used by the criminal. The remarks we have made on the means of inducing premature labour will, we hope, aid you in drawing your conclusions.

Illustrative Cases.

CASE I.—*Hindoo Female. Abortion by Mechanical Violence.* [Dr. Shortt, *loc. cit.*]

Dr. Shortt examined the body, and found the base (or fundus) of the uterus perforated in three places.

CASE II.—*Durham Assizes,* 1781. *Quoted by* Beck. *Abortion produced by Wooden Skewers.*

Margaret Tinckler was indicted for the murder of Janet Parkinson, by inserting pieces of wood into her womb. Deceased took to her bed on the 2nd of July, and from that period said she must die. She died on the 23rd of that month. The dying woman declared she was pregnant about five or six months by a married man. She went to the prisoner, a midwife, who took her round the waist, and violently shook her five or six times, and tossed her up and down, three days before she was delivered. The child was born alive, but died instantly, on the 10th of July. There were no marks of violence on the child. On opening the womb of the mother, there were two holes, caused by wooden skewers!

CASE III.—*Feigned Abortion. Quoted by* Dr. Taylor [*loc. cit.*, p. 198].

A young woman, admitted into Guy's Hospital, in 1846, accused a policeman of having first given her drugs, and then of having used instruments to procure abortion. On Dr. Lever's examining her, he found there was no reason to suppose she had ever been pregnant. Rather the reverse. Similar cases are mentioned by Casper (vol. iii.).

CASE IV.—*Abortion by Savine. Case of* Miss Burns. [*Murder by Poison.*] *See* Beck (*loc. cit.*, pp. 163, 234, 753).

Charles Angus, Esq., of Liverpool, was tried in September, 1808, for the murder by poison of Miss Burns, living in his house. Witnesses proved that she had increased in size, and shortly before death suffered from severe pains for some three days. However, the evidence on this point was contradictory. On opening the body, the uterus was found enlarged, and capable of holding a quart of fluid. Near the fundus there appeared to be the remains of the placenta, and marks of its attachment. The uterine sinuses were large and patent. The walls of the uterus were half an inch thick. Four fingers easily passed the os uteri. The vagina was somewhat dilated, the labia livid, and blood-stained. It appeared from the evidence that oil of savine had been administered. The prisoner was acquitted, chiefly because the medical witnesses differed. Dr. Carson attributed the symptoms to *hydatids* of the uterus. After the trial a *corpus luteum* was found in one ovary, of the character of those due to pregnancy. [See also the "Edinburgh Medical and Surgical Journal," vol. v., p. 220. Other references are given in Beck.]

Case V.—(*From* Tardieu, No. IX.) *Abortion produced at 6½ Months by the use of Rue.*

A girl, aged twenty-five years, 6½ months pregnant, used a decoction of rue internally and externally for several days. She was then suddenly taken with violent and obstinate vomiting, feverishness, somnolence, stupor, vertigo, choreaic movements, incoherent speech, cold extremities, and small and slow pulse, enormous swelling of the tongue, and profuse salivation. In the evening of the second day after the onset of these symptoms, labour-pains set in, and next day she gave birth to twins, both dead. The symptoms were interrupted by the delivery, but returned, and it was twenty-five days before she was well.

Case VI.—(Tardieu, No. X.) *Abortion produced at four Months. Metro-peritonitis. Ergot of Rye found in Substance in the Digestive Canal.*

A girl, aged twenty-four years, was pregnant four months. No one had suspected it save herself. She leaves home one morning in perfect health, consults a midwife, who takes her back in great pain at night. Next day she dies. At the autopsy metro-peritonitis was found, and ergot discovered in the lower third of the bowels. The uterus was found to have been recently emptied. There had probably been manipulations as well as ergot used in this case.

Case VII.—*Abortion at three Months, produced by the Uterine Sound.*

This is No. XVII. of Tardieu's cases. The midwife had introduced her hand, and an instrument. Two midwives were concerned, one of whom confessed. Milk was found in the girl's breasts. A domiciliary visit revealed a packet of dry herbs [reputed abortifacients], a stylet, two knitting-needles, and two silver (uterine) sounds, one of which was admitted to have been used. Wormwood, saffron, and mugwort had previously been administered.

Case VIII.—*Abortion produced by Manipulations with a Knitting-needle. Consecutive Metritis.*

Tardieu's twenty-sixth observation. On October 3rd Tardieu was asked to see a female prisoner, who had aborted on September 1st, by the aid of a midwife. The midwife had several times used a knitting-needle. Tardieu still found signs of delivery, of metritis, but not of any puncture. The appearances were, however, consistent with the woman's statement.

CASE IX.—*Abortion produced at 4½ Months, by violent Means. Perforation of the Womb. Death.*

This is Tardieu's thirty-seventh case, and is taken from Devergie. Marie S——, aged twenty-six, pregnant 4½ months, consulted an *officier de santé* at 10 a.m., on Feb. 24th, 1833, with all the appearances of good health. The same day, at 4 p.m., she took a bath, another the next day, at 11 a.m., and towards 2 p.m. underwent an operation. Thirty hours after she died, on the evening of the 26th. At the post-mortem the neck of the womb was lacerated; and in its fundus there was an opening 4 to 5 centimetres (1⅝ to 2 inches) long, in which were fragments of placenta. In the peritoneum was a vast quantity of blood, and signs of commencing peritonitis.

CASE X.—*Abortion by Violent Means. Wounds of the Uterus, and Internal Iliac Artery. Fatal Hæmorrhage.*

This is Tardieu's fortieth case. Taken from Dr. Raynard, "American Journal of Medical Sciences," 1853, p. 77. The deceased, aged thirty-six, was six months pregnant. She went to a quack, who operated. She died in twelve hours. Four surgeons made the post-mortem. The body was bloodless, the abdominal cavity filled with blood, partly coagulated. The posterior wall of the uterus had an opening, the size of a common sound, which extended into the right internal iliac artery, which was perforated near its origin: the opening in the vessel would admit a goose-quill. Three other punctures existed in the uterus, nearly in the same direction. A probe introduced by the vagina, easily followed their direction. None of these had penetrated the ovum. The membranes were intact, and so was of course the fœtus.

Further illustrative cases will be found in Beck, Taylor, and Tardieu. The latter gives numerous cases of abortion from injections into the uterus. A curious case (No. 41) is that of a woman introducing a needle into her womb, and not being able to withdraw it, it set up an abscess in perinæo, and was discharged from this some weeks after. She recovered, which was more than she had a right to expect.

In Case 51, a brutal husband, to make his wife, who was seven months pregnant, abort, actually tore away through a four-inch rent of the vagina and uterus, not only part of the uterus, but nearly all the woman's small intestines. The child was found between her legs, and had evidently breathed. In another case (No. 52, of Tardieu's), the vulva, perinæum, vagina, uterus, urethra and rectum, had all been cut or dragged away from a young girl. A doctor and midwife were suspected. It appeared, however, probable that the mutilation was post-mortem.

On Certain Conditions which Simulate Pregnancy and Abortion.

In civil practice, medical men meet with numerous cases in which married women imagine they are pregnant when they are not so. Of these the commonest are those where "the wish is father to the thought," in stout women, in whom "fæces, fat and flatus," give rise to abdominal tumour, and to spurious pains, somewhat resembling those of labour. The idea of pregnancy is one form of monomania. As, however, prisoners may in order to simulate pregnancy, voluntarily excite movements of the abdominal muscles, which may simulate uterine contractions, it is well for young practitioners to be on their guard against such a deception. Amenorrhœa, especially if the menses are retained by an imperforate hymen, Ovarian dropsy, ascites, malignant tumours, fibroid tumours of the uterus, physometra, and hydrometra, and uterine hydatids, might all simulate pregnancy, and as many of these set up pains which are really uterine contractions, even experienced accoucheurs have been sometimes deceived for a time. Tardieu gives a number of cases in an appendix to his work, frequently quoted above, on Abortion [" Observations et Recherches pour servir à l'Histoire Médico-légale des Grossesses fausses et simulées."] For the special diagnosis of most of these conditions, reference must be made to special works on the subject of obstetrics, and to periodical medical literature, the "Obstetrical Transactions," &c. Rupture of an ovarian sac distended with fluid would in many respects resemble recent delivery, but if seen almost immediately after, the small size of the uterus would distinguish the case. It is seldom that the breasts sympathize equally with ovarian tumours as with pregnancy. As regards *Hydatids of the Uterus*, which were suggested in Miss Burns' case, the authors have to remark that these are of two kinds: in the first or common kind, known as the *hydatidiform degeneration of the chorion* [see Paget's "Lectures on Surgical Pathology," p. 419; Müller's "Archiv.," 1860, H, v. p. 417; Churchill's "Diseases of Women," p. 281 (5th edition); and papers in the "Obstetrical Transactions," vol. iii., p. 177, vol. i., p. 249, vol. ii., pp. 112, 242, vol. vii., pp. 113, 117, 228, vol. ix., p. 85, vol. x., p. 93]—we believe all obstetric and pathological writers are now agreed that *these are really degenerations of cystic kind of a fœtal structure (the chorion) and therefore mean a previous pregnancy.* There is, however, a second kind, the *true hydatids of the uterus*, which contain *echinococci* or their hooklets (so-called teeth), or the beautiful striated membranes belonging to such, and these are really a peculiar mode of development of tape-worms. These are excessively rare. The authors only know of one case reported by Dr. Graily Hewitt, "Obstet. Trans.," vol. xii., pp. 135 and 237, and of another of hydatids in the vagina by Dr. Braxton Hicks. There may be one or two in foreign medical literature, but they are exceedingly rare. These are quite independent of sexual intercourse as regards the human female. The microscope would be the best means of establishing the diagnosis.

Casts of the Uterus and Vagina are expelled by virgins, as well as other women, suffering from *dysmenorrhœa; polypi and fibrous tumours*, may also be expelled from the virgin uterus with hæmorrhage and pains resembling labour. What are called "fleshy, or carneous moles," are however almost invariably degenerations of the ovum, and contain evidences of fœtal structure. You will, in any doubtful cases, save yourselves from making serious mistakes by—(1) Careful examination of the history of the case; (2) The abdomen should be carefully examined, and the shape of the tumour noted, as well as its feel, and other physical signs. No garment should cover the abdomen in any case of difficulty. Had this rule been observed, the chastity of Lady Flora Hastings had not been impugned; (3) All the circumstances of the case should be noted and duly estimated—the age, general appearance, appearances of breasts, abdominal and uterine symptoms, particularly the size and dimensions of the uterus, the state of the pulse, nature of the discharges, condition of the vagina, and external genitals, &c. A knowledge of your profession, careful examination, and strict regard to truth will generally lead you right. In a doubtful case, if pregnancy be pleaded, report the doubt, and ask for extension of time.

In cases of supposed delivery, if really doubtful, it would seem right to give the accused the benefit of the doubt. Do not assume more than you know. Keep facts and opinions separate.

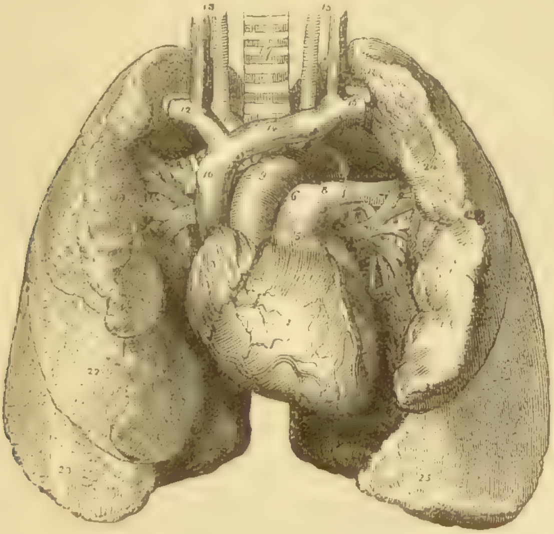
Proofs of Live Birth in relation to Child-murder and Heirship.

Before considering the subject of child-murder, it is necessary to make some preliminary explanations in regard to the changes in circulation and respiration which take place at birth or soon after, and to mention the principal differences between the fœtus in utero and the child who has freely respired, and is severed from its mother.

Preliminary remarks on Circulation and Respiration.

You will remember that the thorax or chest is chiefly occupied with the heart and lungs. Fig. 100 shows the relation of these to one another, to the windpipe, and to the large blood vessels. 17 is the windpipe or trachea, dividing into 18 and 19, the right and left bronchus, almost concealed by the blood-vessels. 1 is the right ventricle of the heart, giving off 5, the pulmonary artery, dividing into 6 and 7, the right and left pulmonary arteries; 9 is the aorta, showing the first and second portions of its arch; 13 and 15 are the right and left carotid arteries; 11 is the innominate artery; 12 and 14 the innominate veins of right and left side; 16 the bronchial veins; 10 the superior vena cava; the internal jugular veins are seen by the side of the carotid arteries; 20, 20, are the right

FIG. 100.



and left pulmonary veins; 21, 22, 23, the lobes of the right lung; 24 and 25, those of the left lung. The relations of these parts to each other are shown by the following section of the thorax (Fig. 101). The letters refer as follows:—V. is a dorsal vertebra, enclosing a section of the spinal cord; R.V. is the right ventricle of the heart; R.A., its right auricle; P.A., the pulmonary artery; A, the aorta; C, the vena cava superior. 1 is the anterior mediastinum; 2 and 3 the triangularis sterni muscles and internal mammary vessels; 4 and 5, the phrenic nerves; 6, pneumogastric nerves; 7, the œsophagus; 8, vena azygos major; 9, descending aorta, with *thoracic duct* close to it; 10, sympathetic nerves.

FIG. 101.

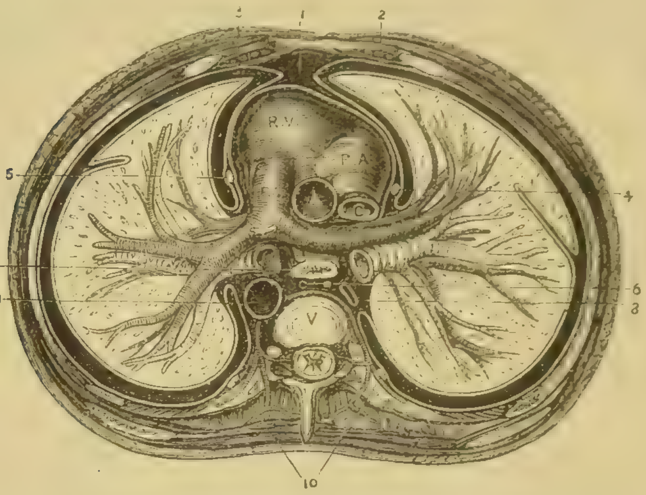
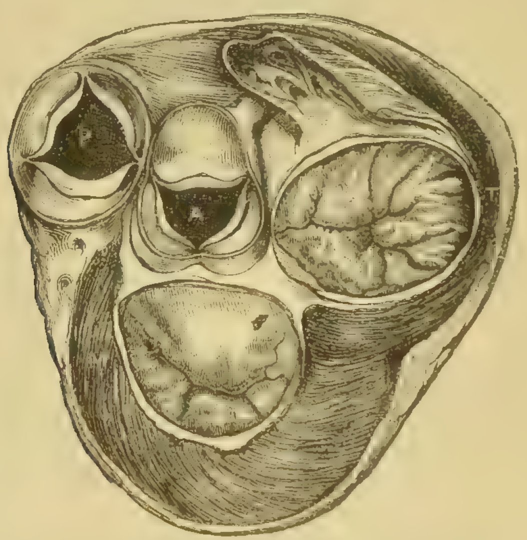


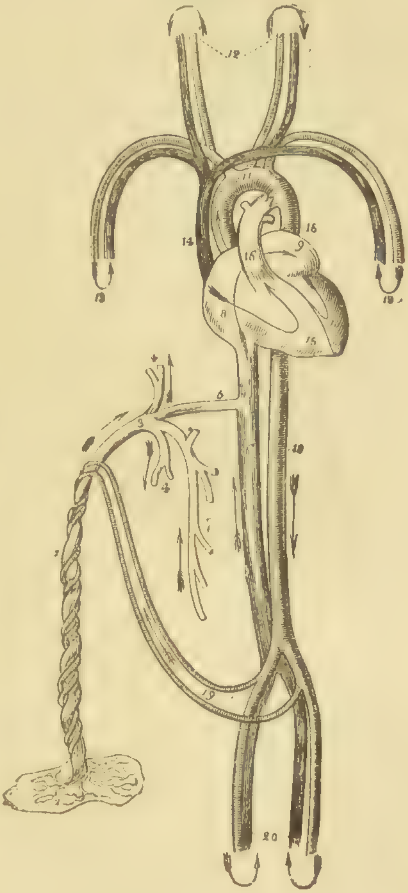
FIG. 102.



The *heart* of an adult, and of a child who has breathed for some time separate from the mother, consists of *four chambers*, all separate from each other—or, to speak more properly, of two hearts—a right or *pul-*

monary heart, consisting of two chambers, the right *auricle* or upper chamber, into which enter the superior and inferior vena cava, returning the blood from the head and upper extremities, and from the trunk and lower extremities respectively, which opens by means of the *tricuspid valve*, T, in Fig. 102, into the right ventricle, or lower chamber, from which the blood is pumped by the pulmonary artery all over the lungs. The opening of this P is also guarded by three semilunar or sigmoid valves. The blood returning from the lungs flows into the left *auricle*, or upper chamber of the left or *systemic heart*, through the pulmonary veins (the opening is sometimes single, sometimes double), from thence it flows through M, the mitral or bicuspid orifice, into the left ventricle or lower chamber of the left heart, which pumps it by means of the aorta all over the body (except the lungs). The orifice of the aorta is guarded by a triple valve (A), called aortic, sigmoid or semi-lunar valves. All these valves are nearly on the same level, as seen in Fig. 102. [Unfortunately this figure is *reversed* as to right and left].

FIG. 103.

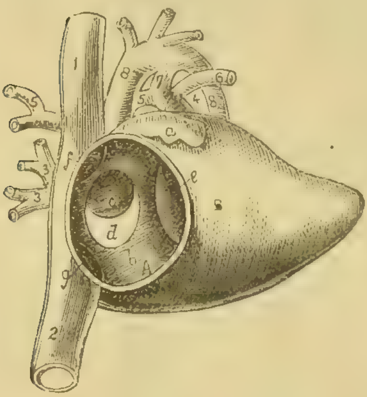


The course of the blood in the *adult* and independent child is therefore as follows:—

LEFT VENTRICLE to *aorta*, *aorta* to head and neck, and upper extremities [this blood returns by *vena cava superior* to *right auricle*], and trunk and lower extremities, and, in fact, all over body except lungs. The blood from the lower extremities and trunk returns by means of the *vena cava inferior* to the RIGHT AURICLE, where it meets the blood from upper extremities and head, &c., returned by *vena cava superior*. Blood goes from RIGHT AURICLE, through TRICUSPID VALVE, to RIGHT VENTRICLE, and is thence pumped through *pulmonary artery* into the (right and left) *lungs*. From these it returns (when aërated) through the *pulmonary veins* into the LEFT AURICLE, and passes, by means of the *mitral valve* into the LEFT VENTRICLE, where we first met with it. There are some peculiarities in the cerebral, pulmonary, renal, hepatic, and intestinal circulations, and in that of the heart itself for which we must refer to special works on physiology (Dr. Carpenter's, Kirke's, Huxley's, Bennett's, Dalton's, and other more recent works). These do not, however, affect the general course of what is called the adult circulation. The only peculiarities we need mention are, that—

Venous or *de-oxygenated* blood is met with in the pulmonary *arteries*, and *arterial*, or *oxygenated* blood, in the pulmonary *veins*. There is, however, no mixture of these two kinds of blood. In the *fœtal* circulation and fœtal heart this admixture, however, does take place, and the general course of this circulation will be best understood by a careful reference to the following figures.—Fig. 103 is a diagram of the fœtal circulation. 1 is the funis, made up of the *umbilical vein* and the *umbilical* or *hypogastric arteries* (19), 2 is the *placenta*, 3 the *hepatic vein*, giving off 4, 4, hepatic bunches, right and left (sometimes there are three or more), 5 is the *ductus venosus*, 6 the *vena cava inferior*, 7 the *portal vein*, 8 is the RIGHT AURICLE, 9 the LEFT AURICLE, 10 the LEFT VENTRICLE, 15 the RIGHT VENTRICLE, 16 the *pulmonary artery*, 17 the *ductus arteriosus*, 18 the *aorta*, descending portion, 11 the *arch* of the aorta, 12 the carotids, 13 the *brachial arteries and veins*, 20 *iliacs and femoral arteries and veins*, 14 is the *vena cava superior*.

Fig. 104.



Whilst the fœtus is *in utero* there is a communication between the right and left auricles, by means of the *foramen ovale* (of which the *fossa ovalis* is the remains in the adult heart), *so that the fœtal heart is really a three-chambered heart.* Fig. 104 shows A, the RIGHT AURICLE laid open; *a* is the appendix of the auricle, *b* the inter-auricular wall or septum between the right and left auricles, B is the outside of the RIGHT VENTRICLE. 1 is the *superior vena cava*, 2 the *inferior vena cava*, 3 the right *pulmonary veins*, 4 the PULMONARY ARTERY, 5 the *right* and 6 the *left pulmonary artery*, 7 the *ductus arteriosus*, 8 the *aorta*, *c* is the *foramen ovale*, partly closed by the valve *d*, *e* the opening into the right ventricle (tricuspid valve), *f* opening of superior vena cava into right auricle, *g* opening of inferior vena cava into lower part of same auricle. [Fig. 282 of Dalton's Physiology, p. 701, shows the relations of these parts extremely well.] We shall now give the *fœtal circulation* in the same manner in which we gave the adult, only instead of starting from the *heart*, we start this time from the *placenta*, or after-birth, when the blood has been purified by admixture (osmosis, or passage through membranes), with the mother's arterial blood. It is thus seen that the placenta corresponds to the lungs of the mature fœtus, its real lungs being as yet only very slightly expanded or developed), just as the allantois and chorion did at earlier periods of fœtal life. In the following description of the

Fœtal Circulation,

the numerals refer to Fig. 103, unless where otherwise stated.

The purified or aërated blood from the *placenta*, or after-birth, goes through the *umbilical vein*, which forms a part of the *funis* or umbilical cord, passes in at the navel, and shortly divides, one part going through the *liver*, right and left, the other part going through the *ductus venosus* (5) into the *vena cava inferior* (6), which conveys it to the RIGHT AURICLE of the heart (8). It does not stop here, but nearly the whole of it is directed through the *foramen ovale* (*c* in fig. 104) into the LEFT AURICLE. There it meets a small quantity of blood returning from the lungs, and mixing with this, passes on through the *mitral valve* (M in fig. 102) into the LEFT VENTRICLE of the heart. This pumps it through the *aorta*, and the chief part of this stream goes at once to the head, neck, and upper extremities of the fœtus [hence, as they get the best part of the best blood, they are more highly developed than some other parts of the fœtus—as it says in the song:—

> "Little Tom Noddy,
> All head and no body!"]

The blood from the head and upper extremities returns by means of the *superior vena cava* to the RIGHT AURICLE. This blood, however, does not pass, like that coming from the placenta, through the foramen ovale, but goes straight on into the RIGHT VENTRICLE of the heart, through the *tricuspid valve* (T in fig. 102). The RIGHT VENTRICLE pumps it by means of the *pulmonary artery* towards the lungs, but they can take only a small part of it—that small part we have already followed in its course—the greater part goes through the *ductus arteriosus* (7 in fig. 104) [known on the Continent as the *Ductus Botalli*, from the name of its discoverer], into the *aorta*, and from this it descends, along with a portion of the blood from the left ventricle (which has not gone to the head, &c.), to the trunk and lower extremities. Arrived at a spot a little below the bladder, a portion of it returns by the *hypogastric* or *umbilical arteries*, to the funis, and on to the placenta, bringing back impure blood to the *placenta*, which returns it again by means of the *umbilical vein* (whence we started). Part of the blood goes on, however, to the lower extremities, and when it has reached the feet, turns back again and is finally returned by the *vena cava inferior*, where it meets the pure blood coming from the placenta through the *ductus venosus*. It will thus be seen that the fœtal circulation presents the following peculiarities:—

1st. Part of the blood from the placenta is delayed in the liver, instead of reaching the vena cava at once. Hence the liver is an important structure in the fœtus, and, as might be supposed, is of large size comparatively. Ultimately, however, this blood goes also into the vena cava (inferior), and reaches the heart like the other.

2nd. The *umbilical vein* and *ductus venosus*, and *ductus arteriosus* [or ductus Botalli], are all peculiar to the fœtus—the two former constituting the round ligament and fibrous cord of the fissure of the ductus venosus of the liver, and the latter an obsolete fibrous cord between the aorta and pulmonary artery in the fully developed child and adult.

3rd. The *foramen ovale* is also peculiarly a fœtal structure, being closed by a membrane at or some time after birth. [*Fossa ovalis* of adult heart.]

4th. The *umbilical or hypogastric* arteries are also fœtal structures, constituting the *superior vesical arteries*, and *anterior true ligaments of the bladder*, in after life.

5th. The *Eustachian valve*, which is far more evident in the fœtal than in the adult heart, serves to guide the blood from the inferior vena cava through the foramen ovale into the left auricle.

6th. We need scarcely remind you that the *placenta*, or after-birth, and the *funis* or cord are dispensed with as soon as the infant has breathed properly.

On the Legal Meaning of Live Birth.

There can be no doubt that in order to acquire civil rights, such as accession to property, an infant must be completely born, that is, its body and all its parts must be completely in the world, or external to the mother. The infant must also manifest some signs of life, if it is to be regarded as born alive. The same entire extrusion is demanded in order that a conviction for infanticide may be obtained. It is not necessary that it should be completely separated from the mother, or that the placenta or after-birth should be separated. Very slight movements of a child, such as the twitching of the muscles of the lips, or of one leg, are held to be evidences of life sufficient at least for civil rights. It is not necessary for the child to cry, though Blackstone [" Comments.," vol. ii., ch. 8, p. 127] says : " *Crying*, indeed, is the strongest evidence, but it is not the *only* evidence." Coke says : " If it be born alive, it is sufficient, though it be not heard to cry, for peradventure it may be born dumb." The same legal authority describes " *motion*, stirring and the like," as proofs of live birth. The Scotch law demands proof of crying for establishing the husband's right of courtesy or liferent in his wife's estate, which appears in that country to depend upon there having been a child of the marriage born alive [see Taylor, vol. ii., p. 209]. The case of *Dobie* v. *Richardson* (Court of Session, 1765) is one in point. Dobie's wife gave birth to a child nine months after marriage which breathed, raised one eyelid, and died in convulsions about half an hour after birth, but was never heard to cry. The mother died in childbed, and the question was whether the *jus mariti* was not lost by the death of the wife within the year, without a child having been born of the marriage which had been heard to cry. This was answered in the affirmative, and it was held that the husband was not entitled to any part of his deceased wife's effects (Beck, *loc. cit.*, 5th edition, p. 195) ; see also the case of *Blackie* (Court of Session, 1833), quoted by Taylor. The case of *Fish* v. *Palmer* (Court of Exchequer, 1806), mentioned by Beck, Taylor, and others, is sufficient to prove the practice of the English Courts, for this question is not settled by statute, but by precedents. The wife of the plaintiff *Fish* had landed estates in her own right. She died in 1796, after having given birth to a child which was supposed at the time to have been born dead, and as it was said she had not had a living child during the marriage, these estates were claimed and taken by the defendant *Palmer*, her heir-at-law, the husband surrendering his rights under the circumstance. Many years after he received information from women present at the birth, which led him to believe that the child had not been born dead, and that the estate had therefore been surrendered to the defendant under a mistake. The action was brought in 1806, ten years after the death of the wife. Dr. Lyon, the accoucheur, was also dead, but it was proved that he had declared the child to be alive an hour before it was born, and at its birth had ordered a warm bath, and given the child to the nurse to put in the bath. The child neither cried nor moved its limbs, but the women swore that when placed in the bath there twice appeared a *twitching* or *tremulous motion of the lips.* They informed Dr. Lyon of this, and he ordered them to blow into its throat.

It did not show any further signs of life. The medical experts, however, differed. Drs. Babington and Haighton admitted the twitching as a sign of life. Dr. Denman looked on it as only the remains of *uterine* life. The Court, however, decided that the child was born living, and the plaintiff thus recovered an estate which he had lost for ten years.

Some of the deepest questions of physiology, and perhaps we might say psychology also, arise in regard to the question, "What really constitutes life, and especially the independent life of the child newly-born, or in the act of being born?" Our own feeling is, that the practice of the English courts is a sensible one, in refusing to entertain these recondite questions, and in deciding that movements are a sign of life. On the other hand, we think the law which requires that a child should be entirely separate from the mother before being considered born, is a direct encouragement to child-murder. There seems, however, no doubt that this is the law as interpreted by our judges. In the case of *Rex* v. *Poulton* ["Chitty Med. Jur.," 412], the medical evidence showed that the child had breathed, but as the medical witnesses, very properly, would not swear that it was wholly born alive, the judge held their evidence to be insufficient to convict the prisoner. Baron Gurney, in *Rex* v. *Simpson*, at Winchester, in March, 1835, stopped the case as soon as the medical witness stated that the lungs might have been inflated during the birth.[*] In spite, however, of what has been said about crying, this act alone is not necessarily a proof of live birth in the legal sense, since a child may cry in utero if air can get in [*vagitus uterinus*], which can only happen after the rupture of the membranes—whilst children often cry when only partially born. In the case of *Brock* v. *Kelly*, heard before Vice-Chancellor Stuart in April, 1861, *pulsation in the cord* or funis was justly held to be a sign of life—since the pulsation would be in the umbilical or hypogastric arteries, due to the action of the child's heart [*see* fœtal circulation]. The opinion of the accoucheur, Dr. Freeman, was supported by Dr. Tyler Smith. Drs. Lee and Ramsbotham gave it as their opinion that there was no proof of breathing having taken place, and that nothing less than breathing could establish the fact of live birth. But we hold that these distinguished accoucheurs were not only legally wrong, which is certain, but also physiologically so, since, as Dr. Taylor remarks, contractility of the heart-muscles is quite as good a proof of life as contractility of the intercostal muscles or diaphragm. The Vice-Chancellor took this view of the case, and decided that proof of breathing was not necessary, and held that there was sufficient legal evidence of life after birth in the pulsation observed by the accoucheur.

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[*] Dr. Taylor has discussed this subject with great clearness, and at considerable length. Whilst referring to him for the details, we think the references given deserve quotation. See Matthew's "Digest. Sup.," 25; Archbold's "Crim. Pleadings," 367; the case of *Rex* v. *Brain*; *Rex* v. *Sellis* [Norfolk Spring Circuit, 1837, before Justice Coltman]; Charge of Baron Parke to Grand Jury at Herts Lent Assizes, 1841 (see "Guy's Hosp. Reports" for 1842). In *Reg.* v. *Christopher*, Dorset Lent Assizes, 1845, Earle, C. J., drew a distinction between *medical* (physiological) and *legal* life. "In law the birth of the child must be complete," "Prov. Medical Journal." April 23, 1845; *Reg.* v. *Stevens*, Baron Alderson, Midland Circuit, 1853. In *Reg.* v. *Taylor* (Hereford Summer Assizes, 1863), the child was heard to cry before being fully born. The prisoner was acquitted. See also Beck, and Dr. Guy's well-known work on the same subject.

Tenancy by Courtesy.

We have incidentally alluded to this in the preceding paragraph. If a married woman possessed of estate die, the estate passes from her husband to her heirs-at-law, unless there has been a child born alive or living, of the marriage, in which case the husband acquires a life interest in the property. Blackstone's "Com.," vol. 2, p. 426, explains that the term means a tenant by the Courts of England. Dr. Taylor sums up the legal conditions of this tenancy as follows:—(1) The child must be born alive—on this point we have already dwelt. In the case of *Llewellyn* v. *Gardiner* (Stafford Lent Assizes, 1854) and *Gardiner* v. *Llewellyn* (Stafford Summer Assizes, 1856), it was sworn by the plaintiff and his sister that a prematurely-born child cried twice. There was, however, no medical evidence, and the jury disbelieved these interested witnesses, as their evidence was quite unsupported by the other facts of the case. In the second action a medical witness deposed that a child born at the fifth month could neither breathe nor cry! In commenting on this ignorant assumption, Dr. Taylor remarks, that one of the greatest difficulties lawyers have in getting at medical truth is the tendency of medical witnesses to act upon a foregone conclusion, and to "fix" all natural events by an exclusive reference to their individual experience. (2) The child must, it would appear, be born whilst the mother is living. Lord Coke and most legal authorities quote a case decided against the husband about three centuries ago, because the child was extracted by the Cæsarian operation, in other words, by cutting into the uterus through the abdomen after the mother was dead. It is possible that, now this operation is more common in England than it once was, this decision might be reversed, were such a case brought before our courts; the more so as it has been decided that a child thus born is legitimate, although death dissolves the marriage! If craniotomy were done without destroying the base of the brain and upper part of the spinal cord, particularly the medulla oblongata, the child might move its limbs, or even cry after it was born mutilated. No such case has however been tried by the courts. ["Guy's Hospital Reports," 1860, p. 477, contain a case reported by Dr. Hicks, which shows that this does sometimes occur.] (3) The child must be born capable of inheriting. See "Monsters and Hermaphrodism," pp. 672 to 679.

General Sketch of the Changes in the Child produced by its Birth and Independent Life.

I. We will begin with the *changes in the funis or umbilical cord*, as these are the most evident. The time at which pulsation in the cord ceases is very variable. In general the pulsation stops in a few seconds or minutes, even when the cord is not tied. The obliteration of the hypogastric arteries and umbilical vein is, according to Billard, effected by concentric or internal thickening. It is usual in England and other civilised countries to tie the funis or umbilical cord, and then to cut it. To meet the case of twins, and also for purposes of cleanliness, it is usual to put two ligatures on the cord, and to cut between them. From 2½ to 3 or 4 inches from the abdomen is the spot usually selected for the ligature, and the cut is made a little way off this. If cut close to the ligature, it might slip, and hæmorrhage occur. It is usual to have a ligature composed of several threads. It should be firmly tied and examined again before the accoucheur leaves the house to see that there is no bleeding. The portion of funis or cord left attached to the body of the child is also generally wrapped in charred rag. In some cases of suspended animation it is proper to wait a little while, or even to cut the cord, and allow a few drops of blood to escape before applying the ligature. But salutary as this hæmorrhage may be, it must be carefully watched, as any considerable excess would be fatal. The authors have known cases of convulsions, and others of death, due to oozing of blood from cords improperly tied by midwives. In from three to five days, as a rule, but sometimes rather more slowly [two to fifteen days "Churchill"], the cord separates from the body, with or without cicatrization of the navel. But the cord begins to shrivel and wither in from twelve to twenty-four hours. The separation takes place close to the body—not where tied—by sloughing; the skin connected with the dead part of the funis or cord has a red line of capillary congestion, or line of demarcation. The arteries of the funis begin to contract in twenty-four hours, at the umbilical end first; in two days this has extended to nearly their whole length; whilst at the end of the third day the contraction reaches nearly to their termination in the iliacs (Guy and Billard). The changes in the veins are not so rapid. Dr. Churchill has treated the subject of hæmorrhage from the funis at some length in his "Theory and Practice of Midwifery," p. 217, &c. He states that these cases are generally accompanied by jaundice.

M. P. Lorain has shown [in his Thesis "De la Fièvre puerpérale chez la Femme, le Fœtus et le Nouveau-né"] that the drying of the cord mentioned above is greatly due to the fact of its being wrapped up and kept at a temperature of about 98 degrees F. and the reason that the cord does not dry much in infants born dead is that the bodies are cold, and are kept so. This is no doubt partly true, for the condition of the cord will be found to vary according to the amount of heat and moisture in the air, and the conditions under which the bodies have been preserved. Hence the seasons of the year will make a difference. This will not, however, deceive those who have studied the subject practically. Tardieu gives a case in which an infant, who only lived a few seconds, was placed near a stove; the greater part of the cord was dried, as if the child had lived, but the part near the middle (it had been left almost entire) had been kept moist by contact with the body. With regard to the period at which the cord falls off, Tardieu (*loc. cit.*) gives the following from M. Bouchaud and Mdme. Alliot, from the Paris Maternité:—

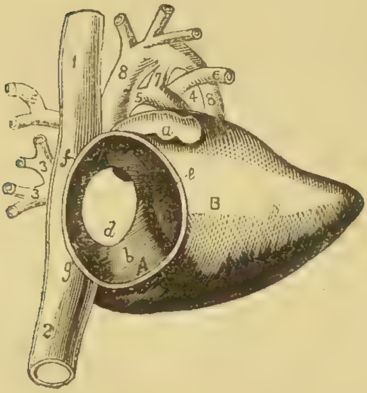
The cord fell off on the

2nd day in	5	cases.	7th day in	9	cases.
3rd "	22	"	8th "	3	"
4th "	36	"	9th "	2	"
5th "	47	"	10th "	2	"
6th "	31	"			

These figures agree with Casper's observations.

It would appear that in vigorous, large, and well-formed infants, the separation of the funis occurs more rapidly than in those who are feeble, small, and immature.

FIG. 105.



II. *Changes in the heart, ductus arteriosus, and ductus venosus, and in the general course of the circulation—Closure of the foramen ovale.* The moment breathing is fully established, a greatly increased quantity of blood goes to the lungs. The course of the circulation at once begins to resemble that of the adult, being now double—*i.e.*, pulmonic and systemic (*see* p. 765), and this resemblance becomes closer day by day until perfect identity in the course of the circulation is established. Fig. 105, from Dr. Taylor, shows the *closure of the foramen ovale*, advanced so far that only a very minute aperture is left at the upper part. Here *d* shows the membrane, almost closing the foramen or opening *e* between the right and left auricles; *f*, opening of superior vena cava; *g*, opening of the inferior ditto; 1, is the superior vena cava; 2, the inferior vena cava; 3, 3, the right pulmonary veins; 4, trunk of the pulmonary artery with its two branches; 5, the right, and 6, the left pulmonary artery; 7 is the *ductus arteriosus;* 8, the aorta. At very early periods of fœtal life no membrane or valve is seen, but about the 12th week it begins to appear. As a general rule the closure of the foramen ovale by this membrane has advanced so far in mature children as to be nearly closed at birth, and completely so soon after. Like Dr. Taylor and all the practical writers on this subject, the authors have met with numerous exceptions. It is sometimes never closed, constituting one form of the disease called *cyanosis.* Some children do not get it closed till about their second year. When patent there is generally a blowing murmur a little before and with the systole. According to Billard, the closure generally takes place between the second and third days. Cases of its closure before birth have been known. It therefore possesses by itself but little medico-legal value, but taken along with other signs would greatly strengthen the probability of live birth, and of life after birth.

As regards the *ductus arteriosus,* or communication between the aorta and pulmonary artery, the facts seem to be as follows: This vessel or duct, which is about half-an-inch long, begins to close as soon as respiration is fairly established. It begins to close first at the aortic end, and according to Bernt of Vienna, assumes, if the child has breathed only a few seconds, from this contraction, a funnel or cone-like shape, with the broad end nearest the pulmonary artery. If, he says, it has lived for a few hours, or a whole day, it is again cylindrical, but shortened and narrowed. If the child has lived several days, or a whole week, the duct becomes narrowed to the diameter of a few lines—say a crow-quill—whilst the two branches of the pulmonary artery equal in size a goose-quill. If the child has lived longer still, several weeks, or perhaps months, the duct is found perfectly closed, impervious and cord-like. Dr. Norman Cheevers shows that this *ductus arteriosus* may be closed before birth, or may remain pervious in some cases a long while, even to adult life, of which the authors have seen instances, constituting one form of *cyanosis.* The case of *Frith* (Ayr Circ. Court of Justiciary, Oct. 1846), quoted by Taylor, p. 369, *loc. cit.*, is of great importance, as the duct was found perfectly closed in a child who had probably lived only ten minutes after birth ["Medical Gazette," vol. xxxviii., p. 897; "Edinburgh Monthly Journal," Nov. 1846, p. 385].

As regards the *ductus venosus*, the exact time of its closure is still less perfectly known. Its closure probably begins in most cases on the second or third day after birth.

The high sounding name of *Docimasia* * *circulationis* has been given to the examination of the appearances presented by the organs of circulation as described above. It is pretty generally agreed that but little importance can be attributed in a medico-legal point of view to any one of these signs taken singly, or to all together, unless corroborated by other evidence, such as that drawn from the organs of respiration (docimasia pulmonum), of which we shall presently speak. Dr. Guy gives the following table from Billard: †

Days.	Umbilical Cord.	Foramen Ovale.	Ductus Arteriosus.	Umbilical Arteries.	Umbilical Veins.	Ductus Venosus.
		Open per Cent.	Open per Cent.			
1	Withering.	74	68	Open.	Open.	Open.
2	"	68	59	Obliteration advanced.	Open.	Open.
3	Dessicating.	64	68	Obliterated.	Open.	Open.
4	Separating.	63	63	"	Contracted.	Contracted.
5	"	45	52	"	Obliterated.	Contracted.
8	Separation complete.	25	15			
10 to 12	Cicatrization commencing. Complete.					

III.—*Changes in the Skin.* These may begin on the first day after birth, or be delayed until the third or fourth day, and may not be completed until from thirty to sixty days. The epidermis, cuticle, or scarf-skin begins to exfoliate, or scale off, sometimes in layers or scales, sometimes as a dust only. This scaling is said to begin on the abdomen and spread to the chest, groins, axillæ, interscapular space, and limbs, ending with the hands and feet. This is a vital phenomenon—and when it has taken place, is a clear proof that the child has survived its birth. It is very different to the changes produced by maceration, which are more closely allied to putrefaction.

IV.—*Changes in the Lungs and Organs of Respiration.* The lungs of an unborn child, or of one which has never breathed, do not nearly fill the chest—the *thymus* gland (which must not be confounded with the *thyroid* body) and the pericardium occupy a prominent central position—the lungs being at the sides and sometimes almost invisible. It has been said that the exterior of the chest is also much flatter than after birth, and Daniel has given measurements, which are justly rejected by Tardieu, Taylor, and other authorities. The lungs themselves, before breathing, are of uniform solid texture like liver, instead of being light and spongy. Their colour is usually a dark maroon, or liver colour, but it may vary from brownish-red to bluish or deep violet. There may also be melanotic spots. The air-vesicles (air-cells or alveoli) cannot be distinguished, though the outside is marked by some furrows, more evident after maceration, which mark out the lobules. There is no feeling of crepitation (crackling, doughy feel), on handling or incising them. The *absolute* weight of lungs which have never breathed is less than after breathing. To weigh the lungs, a ligature should be placed round the root of each lung so as to compress the pulmonary vessels, and prevent the escape of blood. The weight should be taken in grains. Dr. Taylor gives the average weight for nine cases before respiration at 649 grains; Dr. Traill 430 to 600 grains; Dr. Guy states [from 400 cases] the average weight of the lungs of still-born children to be 874 grains, of the lungs of those who survived their birth one month or less, 1072 grains. Dr. Guy gives the following observations [from thirty-four cases].

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* Dŏcĭmăsia, *æ*, f., from Δοκιμάζω. to examine, a term much used by Continental medico-legists.

† "Maladies des Enfans."

	Before Respiration.	After Respiration.
Maximum	1950	1203
Minimum	510	510
Mean (average)	769	820

From which it would appear that the lungs in one or two cases were actually *heavier* before respiration—so that it will not do to trust to this so-called test. Dr. Taylor gives the average of three cases at 927 grains, but gives another case of lungs weighing 1200 grains, which were perfectly airless. The ratio of the weight of the lungs to the weight of the rest of the body [so-called *Ploucquet's test*] is less before respiration than after. Ploucquet thought it was 1 to 70, in children who had not breathed, and 2 to 70 (or 1 to 35) in children who had breathed, and expanded their lungs. Tardieu has, however, collected all the cases he could find from Schmidt, Devergie, Elsaesser, Samson Himmelstiern, and Casper, and the result is that the ratio before breathing appears to be 1 to 60, and after breathing 1 to 53. The general mean of the maxima in both cases is, however, nearly identical, being 1 to 30 in one case, and 1 to 31 in the other. Casper and Taylor are therefore perfectly justified in rejecting this test of Ploucquet's. If, however, we can place but little reliance on the absolute or relative weight of the lungs, it is far otherwise with their colour, appearance, and buoyancy. After respiration the lungs acquire a light red, or pink hue, which is often called vermilion. The colour varies with the amount of expansion and aeration. If breathing has been imperfect they will be mottled about the anterior surfaces and margins, patches of light red being mixed with the livid fœtal hue, and these patches are slightly raised above the general surface of the organs. "The right lung, especially the edges and concave surface of its upper lobe, admits air most readily; it is here, therefore, that first effects of inflation or respiration must be looked for." [Guy.] *The chief difference in lungs which have breathed, is that the air-cells* (alveoli, air-vesicles) *are now visible to the naked eye.* Rarely, a lens of very low power may be needed, but hardly if the examiner has normal vision. These air-cells are in groups—often symmetrical groups of four—they are angular or polygonal, though from their small size they often look almost circular, like little beads or globules of millet seeds. If the lungs are fresh, and contain a good deal of blood, their colour is very bright. If less fresh, or less full of blood, the colour is proportionably paler. You should make yourselves familiar with the appearance of the air-cells, as it is almost impossible to convey it well in a woodcut, though the one given by Dr. Guy (p. 84), is a pretty good representation. Tardieu gives coloured views of lungs which have, and have not, breathed, which are also fairly true to nature. Any one who has once seen the air-cells of the fœtal lung would scarcely confound them with spots of blood, or of pigment (the melanotic spots of authors). Air blown into the sub-pleural and interlobular tissue, or the gas derived from putrefaction, may be known by the larger size and circular shape of the bubbles, by their varying much more in size, and by the fact that the air or gas follows the pressure of the finger—whilst no pressure will efface the air-vesicles. The lung which has breathed may not contain more blood than the one which has not, but the blood it does contain will be frothy. The developed air-cells may be found in lungs which have been artificially inflated, whether before or after death. They do not therefore prove respiration so much as aeration. But the lungs, if well expanded, in other words, if breathing has been well done, now fill the chest—the chest itself becomes more rounded—less of the heart and thymus gland will be uncovered, or visible. The next important change produced, is that the lung which has breathed, will now float—at all events those portions in which the air-vesicles have been expanded. When both lungs have been well expanded by the act of breathing, the two lungs together will not only float themselves, but will buoy up the heart. This buoyancy constitutes what is called the *hydrostatic test*[*]—which is properly not a test of live birth, but a test of respiration. We shall, however, return to the subject again. Note further that no amount of pressure short of that which would destroy its structure, will expel the air from the lung which has breathed. Like Casper, the authors have often applied the weight of the body, and stamping upon the lung, to test this property—but yet the air remained. On the other hand, the air or gas due to putrefaction can be squeezed almost entirely out of the lung. It is important, in the interests of truth, to bear in mind that premature or delicate children may live for a considerable time with their lungs only partially, indeed very partially expanded. This condition is known by the name of *Atalectasis pulmonum.*[†] This was first pointed out, at least in modern times, by Jörg, [Die Fötuslunge, Grimma, 1835]. Long-continued pressure on the child's head is said to be a cause. Dr. Taylor quotes a case from Dr. Burke Ryan, in which a child lived five weeks, and yet the lungs sank in water, and no portion of them floated. Other cases are mentioned by him, in which children lived for less extended periods, with more or less atalectasis. He also gives several cases in which life has been prolonged for several hours, and even days, with complete want of expansion of lungs—complete atalectasis, as it has been erroneously called. We find a still more recent case in "Virchow's

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[*] The specific gravity of the lungs is said to be 1040 to 1050 before respiration, (water being 1000) and only 940 *after* respiration [or 1·04 to 1·05 before, and 0·94 after.

[†] ἀτελὴς, imperfect, ἔκτασις, expansion. [Mayne's Lexicon.]

Archiv," Bd. 66, Heft. 3, from Dr. Erman of Hamburg. A woman gave birth to three children at seven and a half months' gestation. One was born dead. Two were alive, and both cried so loudly as to be heard in an adjoining room. They died in half an hour. The whole of the lungs of one child sank in water—and nearly all those of the other—only a very small portion of the edge of the right lung floated. These lungs were dense, bluish, and quite undistended. Such children are darker (more livid), and colder than others, and their life is easily extinguished. Dr. Taylor quotes a case from Mr. Hurd, of Frome, in which the cord ceased to pulsate eight minutes before birth. The child was born apparently dead, and the first sign of life was after twenty minutes' artificial respiration and a warm bath. The respiration had to be continued three-quarters of an hour before it could breathe for itself. Similar cases have occurred to the authors. In one case of Dr. Woodman's, more than half an hour's artificial respiration was required to get any sign of life, beyond warmth, and slight twitching. *Red hepatization*, *congestion of the lungs*, *pulmonary apoplexy*, *congenital tumours* (cancer, etc.), and *œdema of lungs*, together with condensation or collapse from fluid in the pleuræ, would all cause the lungs to sink in water, and prevent the appearances described as normal. All these are, however, rare events at this age.

V. *Changes in the Stomach, etc.*—In a child which has lived a few hours there will nearly always be found food of some kind (milk, butter, and sugar, farinaceous or starchy food), and sometimes medicines (castor oil, &c.), in the stomach or small intestines. Mucus will be found even in still-born infants, and is therefore of little value. The presence of air bubbles in the mucus of the stomach may possibly be due to artificial inflation, but is more often due to the rolling movements of the tongue, swallowing, &c. Tardieu thinks ten or fifteen minutes' life may generally be inferred from this frothy (air-holding) mucus. The microscope will detect milk, starch, and other kinds of food. Iodine turns starch blue. Sugar may be detected by boiling with cupric sulphate and potash solution (familiar to students in testing diabetic urine). A solution of *cane* sugar, however, requires boiling with dilute sulphuric or some other acid, before trying the copper test. *Meconium* or first fæces (known by cholestrine crystals, greenish ovoid or globular masses of bile pigment, epithelial cells, and mucus granules and corpuscles) and blood may also be swallowed and found in the stomach very soon after birth. Having now given this general sketch of the changes produced in the fœtus by birth, we must proceed to deal separately with the medico-legal questions arising out of the crime of infanticide, first giving, from Tardieu (*loc. cit.*), the following *résumé* of the ordinary time required for the changes we have mentioned. Casper, Taylor, and other good authors, agree in the main with this statement:—

TIME.	SYMPTOMS.
A few minutes to some hours.	The stomach contains a frothy fluid, and a clot forms in the vessels of the umbilical cord.
After six hours.	Obliteration of umbilical arteries?
After the 1st day.	The cord is beginning to separate.
After the 2nd day.	The epidermis begins to exfoliate.
After the 4th day.	The cord falls off.
From 6th to 10th day.	The fœtal openings become obliterated (*i.e.*, ductus venosus, ductus arteriosus, and foramen ovale).
After the 10th day.	The osseous centre of the femoral epiphysis is more than 5 to 6 *mm.* in diameter [⅕th to ¼th of an inch].

General Considerations on Infanticide, and Questions likely to be asked of the Medical Jurist or Expert.

We do not purpose to offer any statistics to prove the frequency of the crime. A glance at the daily newspapers will show that it is far too frequent even in England. Whilst severe seasons, times of famine and the like, may have their influence, the crime is usually committed to save the reputation of the mother, and hence the greater number of these cases occur in illegitimate children. As our laws, from motives of prudence, but very unjustly, throw almost the whole cost of the child's maintenance on the mother at a time when she is least fit to maintain it, and as, besides this, the woman suffers the pains of childbirth, and is too often deceived and wronged, both judges and juries, members of the bar, and witnesses, are all reluctant to convict a woman of infanticide. Dr. Guy supposes that the extreme severity of a former statute (21 Jac. I. cap. 27, on which Sir Walter Scott founded the chief incidents of "The Heart of Mid-Lothian,") which virtually visited the concealment of shame with the punishment of murder, has a good deal to do with this. We do not think it necessary to go back so far. The causes are rather to be sought in the complex state of modern society, and in the workings of conscience. In 1803, the law of infanticide was altered by a statute which puts infanticide on the same footing as ordinary murder, but provides that if acquitted of infanticide, a woman may be tried for concealment of the birth, and if found guilty, punished by imprisonment for a term not exceeding two years. An Act passed in June, 1828 (9 Georgii IV. cap. 31), confirms this, and also provides that it shall not be necessary *quoad* concealment to prove whether the child died before, at, or after its birth. The Consolidation Act (24 & 25 Victoriæ, cap. 100) adopts and extends these provisions. The section (60) as to *Concealing the birth of a child*, is to the following effect:—"If any woman shall be delivered of a child, every person [and this includes doctor or midwife or nurse], who shall, by any secret disposition of the dead body of the said child, whether such child died before, at, or after its birth, endeavour to conceal the birth thereof, shall be guilty of a misdemeanor, and being convicted thereof, shall be liable, at the discretion of the Court, to be imprisoned for any term not exceeding two years, with or without hard labour; provided that if any person tried for the murder of any child shall be acquitted thereof, it shall be lawful for the jury, by whose verdict such person shall be acquitted, to find, provided it shall so appear in evidence, that the child had recently been born, and that such person did, by some secret disposition of the dead body of such child, endeavour to conceal the birth thereof, and thereupon the Court may pass such sentence as if such person had been convicted upon an indictment for the concealment of the birth." [We have taken this summary of the English law almost verbatim from Dr. Guy. In Beck, the reader will find a summary of the laws of various nations, ancient and modern.]

If your opinion be asked on a case of *concealment of birth*, you may have either (1) to examine the woman suspected, or (2) to examine what is supposed to be an embryo or fœtus, or (3) to report on certain symptoms supposed to be indicative of pregnancy or delivery. The soiled sheets, bedding, articles of dress, or discharges, may also be sent to you for examination and report. The remarks already made on the diagnosis of pregnancy and recent delivery [pages 687 and 705], and those on the character of the ovum [pages 644—647], and on the marks of blood, and of the liquor amnii [pages 576 and 758] will, we think, save you from making any serious errors on this subject. For the sake of completeness we will, however, remark that pregnancy[*] [or delivery, as the case may be], may be simulated by the following conditions:—

1. Corpulency. 2. Flatulent distention of abdomen, or tympanitis. 3. Diseases or habits inducing morning sickness, hæmorrhages, or enlargement of abdomen—such as kidney, liver, and heart disease, ascites, ovarian and other tumours springing from the pelvis or the pelvic organs. 4. Hydatids of the uterus [the common variety being due to impregnation and subsequent disease of the chorion, &c.]. 5. Physometra. 6. Menorrhagia and metrorrhagia. 7. Hypertrophy of the breasts and milk in these organs. 8. Contractions of abdominal muscles. 9. Movements from within, due to uterine contraction, the presence and movements of gases, and perhaps intestinal worms. 10. Amenorrhœa, and particularly retention of menses by imperforate hymen.

The substances most likely to be mistaken for an embryo, fœtus, or child, are blood-clots or coagula, fibroid or polypoid tumours, which are sometimes spontaneously expelled; hydatids of the uterus or vagina, truly so-called (see page 762), dysmenorrhæal *casts* of the uterus or vagina, and casts of the rectum in membranous proctitis. Remember that except by the discovery of fœtal hairs or epithelium in quantity, or of meconium, and the peculiar smell when fresh, the stains produced by Liquor amnii cannot be positively sworn to. And although menstrual blood usually contains little fibrin, yet it sometimes coagulates freely; and blood lost from tumours of the uterus is by no means deficient in fibrin.

Returning to the subject of infanticide, it may be said that the

Questions likely to arise in cases of Infanticide

may be all arranged under three heads, viz.:—

I. Was the child, whose body is found, mature? and is it *identical?* In other words, Do mother and child correspond to one another?

II. Was it born alive? and if so, how long did it live?

III. Was it murdered, and if so, how and when?

We have omitted asking by *whom* the murder was committed, as except in cases of puerperal mania, and the like, this is rather a legal than a medical question.

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[*] Dr. Montgomery, in his "Signs and Symptoms of Pregnancy," after an able summary of these conditions, gives the following references:—Ramsbotham's "Practical Observations," part II., p. 387; Gooch on "Diseases of Females," p. 225; Perfect's "Cases in Midwifery," vol. i. p. *293; Alexander Hamilton on "Female Complaints," p. 125; Blundell, "Principles of Obstetricy," p. 160; Schmitt, 7th, 8th, 13th, and 19th cases, 1st. division, and "Critical Introduction," p. 44; Gardien, "Traité des Accouchemens," tom. i. p. 542; La Motte, ch. viii., "de la Fausse Grossesse," p. 47; "Fothergill's Works," by Elliott, 1781, p. 464; "Mauriceau," obs. 275, and 566. We may add to these Tardieu's Appendix to his "Etude sur l'Avortement," 3ieme ed., 1868, and most modern works on Obstetrics.

I. *Signs of Maturity in the Child.*

We do not purpose to repeat the general characters of the ovum at different ages, which were given at page 644, &c., and in the chapter on age. Nor do we purpose giving the tables of measurements *in extenso*, on which the following particulars are founded :—

On the question of maturity Casper relies on the following. 1. A certain general *habitus* familiar to experts. 2. The colour is paler (in general) than that of less mature fœtuses, and the skin usually tenser and more firm. 3. The *down* (lanugo) has to a great extent disappeared, and 4. there is more or less *hair* on the head, often $\frac{3}{4}$ of an inch or more long. 5. The skull bones are not very movable ; the large anterior fontanelle averages $\frac{3}{4}$ to 1 inch in length. 6. *The average length* of the body in 247 mature children, in both sexes, was $18\frac{4}{5}$ inches.
In 130 *male* children $19\frac{5}{6}$,,
,, 117 female ,, $18\frac{5}{8}$,,

7. In the same children, the average *weight* of both sexes was $7\frac{1}{20}$ pounds.
In the 130 *males* $7\frac{1}{3}$,,
,, ,, 117 *females* $6\frac{4}{5}$,,

The *maximum length* was 22 inches, the *minimum* 16 inches. The *maximum weight* 10 pounds, the *minimum weight* $4\frac{1}{2}$ pounds.

In 207 mature children the *average diameters of the head* were transversely $3\frac{1}{5}$ inches, longitudinally $4\frac{7}{8}$ inches, diagonally $4\frac{7}{8}$ inches.* The average diameter *across the shoulders* in 117 mature children was $4\frac{15}{16}$ inches.

The average diameter *across the hips* in 117 mature children was $3\frac{5}{13}$ inches.†

Quételet, in his "Anthropomètrie," gives the following as the—

Height or Length of New-born Children.

	Boys.		Girls.	
	Millimètres.	Inches.	Millimètres.	Inches.
Maximum.	532·68	20·97	554·93	21·87
Minimum.	437·63	17·24	437·63	17·24
Average.	500·66	19·72	490·56	19·34

And he states the average *weight* at birth as 3·1 kilogrammes, or, 6·8 pounds for boys, and 3 kilogrammes, or 6·6 pounds, for girls. Dr. Taylor gives 16 to 21 inches, and 5 to 9 pounds, but mentions cases of children exceeding these. Mr. Owens, in the "Lancet," December, 1838, mentions a child at delivery weighing $17\frac{3}{4}$ pounds, and measuring 24 inches. Dr. Meadows reported another case in the "Medical Times and Gazette," August 4, 1860, in which a child weighed 18 pounds 2 ounces, and measured 32 inches. Dr. Taylor mentions a male child measuring 22 inches, and weighing $12\frac{1}{2}$ pounds. Dr. Ramsbotham speaks of 18 pounds as occurring once or twice in his practice. One of the Authors met with a child who weighed 20 pounds two days after birth. Dr. Matthews Duncan says the length and weight of the child vary according to the age of the mother, being greatest when the mother is from twenty-five to twenty-nine years of age. See Ellsässer, in "Henke's Zeitschrift," 1841, vol. ii., p. 235.

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* Tardieu says this is too small. He gives occipito-frontal $4\frac{1}{3}$ to $4\frac{1}{2}$ inches, Biparietal $3\frac{5}{8}$ to $3\frac{3}{4}$ inches. [*See* page 746.]

† Those who wish for the grounds of the rules laid down will find extensive tables in Casper's "Medical Jurisprudence," [Dr. Balfour's Translation], vol. iii., p. 19 to 29 ; Tardieu's "Étude sur l'Infanticide," Paris, 1868, p. 29 to 39 ; Dr. Guy's "Forensic Medicine," pp. 70 and 71, 3rd edition, and in the serials devoted to this subject.

It is popularly supposed that heavy and tall children have been retained longer than usual in utero. This does not seem to be proved ; indeed it was not so in the cases named above. Tardieu's averages are 18 to 20 inches, and 6 to 7 pounds.* But smaller children may be born at term. Dr. Guy has summarised the various French and English statements as follows:—1st. with regard to length :—greatest, 26 inches ; least, 17 inches ; average, 19 inches [but Dr. Meadow's case was 32 inches]. The weight, which, he says is derived from 20,000 observations, is as follows :—Greatest, 14 lbs. ; least, 2 lbs. 6 oz. ; *average*, 6 lbs. 11 oz. [but as mentioned above, larger weights have been met with]. He says that, as a general rule, *still-born children are heavier and longer than those born alive, males than females, single children, cœteris paribus, than twins, and twins than triplets.* This statement is followed in the original with tables of the greatest, least, and average weights and lengths of the fœtus, founded on 293 and 271 observations respectively.

Casper goes on to show (8) that in mature children the *nails* feel horny, and reach the tips of the fingers (never those of the toes) ; (9) the *cartilages* of the ears and nose feel tolerably like cartilage.

But above all, (10) the *centre* of *ossification* of the *inferior femoral epiphysis* (as pointed out by Béclard, Ollivier, and Wildner) is present in the mature child, in the second half of the tenth (lunar) month. Casper has made observations in 125 cases, the results being as under :—

	No. of children observed.	Size of osseous nucleus.
In the 7th (solar) month	31	0
„ 8th „ „		
„ 9th „ „	9	0 to 2 lines.
„ mature	52	$\frac{3}{4}$ to 4 „

"To find this, make a horizontal incision through the skin and superficial tissues over the knee-joint down to the cartilages, remove the patella, and make the end of the femur protrude. Then remove the horizontal sections from the cartilaginous epiphysis, at first boldly, but so soon as a coloured point is observed in the last section, then very carefully, layer by layer, till the greatest diameter of the osseous nucleus is attained. This appears to the naked eye as a more or less circular blood-red spot in the midst of the milk-white cartilage in which vascular convolutions can be distinctly recognised." If there is no visible trace of this the fœtus cannot be more than 36 to 37 weeks old. If the size of a hempseed, or the head of an ordinary fly (half a line), it corresponds to 37 or 38 weeks if still-born. When $\frac{3}{4}$ to 3 lines, it indicates a uterine age of 40 weeks. If more than 3 lines, the child has probably lived after birth. Ollivier d'Angers has given the following measurements of this osseous nucleus from 50 infants, from the day of birth to one year old:—

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* Of 4104 infants at the Maternité, Madame Alliott found 2,142 weighing from 6·6 to 7·7 pounds.

At term, from . . .	$\frac{1}{25}$ to $\frac{2}{25}$ by $\frac{1}{6}$ or $\frac{1}{5}$ of an inch.
13 to 20 days . . .	$\frac{1}{4}$ by $\frac{1}{5}$ of an inch.
Above 20 days . . .	$\frac{7}{25}$ by $\frac{1}{5}$ „
„ 8 months . .	$\frac{1}{2}$ in. by $\frac{1}{5}$ „
„ 9 „ . . .	$\frac{3}{5}$ „ „ $\frac{1}{2}$ „
„ 11 „ . . .	$\frac{3}{5}$ to $\frac{13}{25}$ „

Casper quotes from Günz ["der Leichnam des Neugeboren," Leipzig, 1827, p. 82], the following:—

Dimensions of the Bones of a Mature Child.

Height of frontal part of frontal bone	2 inches	3 lines.
Breadth of same	1 „	10 „
Length of the *pars orbitalis*	1 „	
Breadth of the same	1 „	
Parietal bone from anterior superior angle to inferior posterior one	3 „	3 lines.
Ditto from anterior inferior angle to superior posterior one ...	3 „	3 „
Height of *pars occipitalis* of Os occipitis	2 „	— „
Breadth of the same	1 „	10 „
Height of squamous portion of temporal bone from upper edge of auditory foramen	1 „	— „
Height of malar bone	— „	6 „
Breadth of the same...	1 „	— „
Height of nasal bone	— „	5 „
Breadth	— „	3 „
Height of the superior maxillary bone from the *processus alveolaris* to the apex of the *processus nasalis*	1 „	— „
Length of superior maxillary bone from the *anterior nasal spine* to the apex of the *processus zygomaticus*	1 „	1 „
Length of each half of the lower jaw	1 „	10 „
Breadth of lower jaw	— „	7 „
Length of the seven cervical vertebræ	1 „	3 „
Length of the twelve dorsal „	3 „	9 „
„ „ five lumbar „	2 „	3 „
„ „ sacrum and coccyx	2 „	3 „
„ „ collar bone	1 „	7 „
„ „ shoulder blade	1 „	6 „
Breadth of the „ „	1 „	2 „
Length of the humerus	3 „	— „
„ „ ulna	2 „	10 „
„ „ radius	2 „	8 „
„ „ femur	3 „	6 „
„ „ patella	— „	9 „
Breadth „ „	— „	8 „
Length of the tibia	3 „	2 „
„ „ fibula	3 „	1 „

11. The *testicles* will probably be in the scrotum. This may occur as early as the thirtieth week. To this the Authors' experience at the Children's Hospital gives many exceptions, probably not less than 3 or 4 per cent. It is, however, rare to find both undescended.

The *scrotum* is corrugated, and the *labia majora* in the female should cover the vagina and clitoris, which should no longer be prominent. The exceptions to this are, however, very numerous.

12. The umbilical cord is usually as long as the body, 18 to 21 inches.* It may be much longer, and sometimes shorter. This, and the position of the navel in the *centre* of the length, though usual, are liable, like many other signs of maturity, to exceptions so numerous as to deprive them of any forensic value. The subjoined table from Tardieu, contrasts the fœtus at various periods; and nearly all modern writers agree in the main facts.

Table showing the Character of the Fœtus at different Ages of Intra-Uterine Life.

Ages.	General Development of Body.		State of the Skin, &c.	Degree to which Ossification has advanced.
	Height.	Weight.		
From 1 month to 1½ month.	⅜ to ⅝ of an inch.	15 to 46 grs.	Skin quite transparent, of a purplish red colour, with no trace of hairs on it.	Centres of ossification for clavicles, and lower jaw. Appearance of dental papillæ in the furrow of the lower jaw.
From 1½ to 2 months.	¾ to 2 inches.	77 to 155 ,,		
From the 2nd to the 3rd month.	2 to 4 ,,	ʒvj to 1½ oz.		
From the 3rd to the 4th month.	4 to 6 ,,	1½ oz. to 4½ oz.	Development of nails. Appearance of matrix of nail. Sex distinct.	Centre of ossification in ischium.
From the 4th to the 5th month.	6 to [illegible] ,,	6 to 8 oz.	Hair-germs appear on the forehead and eye-brows.	Ossification of os calcis.
From the 5th to the 6th month.	10 to 12 ,,	8 to 12 ,,	Hairs appear on the limbs.	Osseous centres for astragalus and os pubis.
From the 6th to the 7th month.	12 to 14 ,,	15 to 32 ,,	Hairs on hands and feet. Membrana pupillaris begins to disappear.	Three or four osseous centres in sternum.
From the 7th to the 8th month.	14 to 16 ,,	2 to 3 pounds.	Skin has lost its transparency. Epidermis distinct. Colour pale pink.	Ossification of lower vertebræ of sacrum.
From the 8th to the 9th month.	16 to 18 ,,	3 to 5 ,,	Skin is covered with sebaceous materials. [Vernix caseosa.] The nails do not reach tips of fingers.	
At term (mature).	18 to 20 ,,	6 to 7 ,,	Sebaceous covering still thicker. Nails overlap fingers. Membrana pupillaris has quite disappeared. Navel a little below middle of entire length of body.	An osseous nucleus in the condyloid epiphysis of femur. The alveolar processes of the lower jaw are now perfectly distinct.

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* The placenta at term presents a diameter of 8 to 10 inches, and weighs from 15 to 19 ounces. Négrier ("Annales d'Hyg. et de Méd. lég," 1re série, t. xxv., p. 126), gives the following figures of the length of the cord, measured in 166 cases:—In 28, he found it less than 17¼ inches; in 112, from 17½ inches to 26¾ inches; in 24 cases, a little less than 27 inches; in 2 cases it was more than a mètre (39⅓ inches).

Tardieu gives the following weights for the viscera of mature children (infants at term):—

Right Lung	509·52 grains.
Left „	440·04 „
Heart	231·6 „
Thymus gland	131·24 „
Liver	1412·26 „
Brains (including cerebellum, &c.) .	10½ ounces.
Spleen	131·24 grains.
Kidneys each	169·84 „

This may be more easily remembered thus:—The lungs weigh separately over an ounce, particularly the right, which is more than a dram in excess. The heart weighs about half an ounce, the liver a little less than four ounces, the thymus, spleen, and two kidneys, altogether, about 1½ oz. The brains weigh more than all these other viscera together.

The question of *identity*, or of the correspondence of the mother and child, will be settled, if capable of solution, by careful attention to the signs of age and development of the child (according to the rules we have laid down), and of the period to which pregnancy has proceeded in the supposed mother.

For reasons which will be given under the headings of legitimacy and superfœtation, no reliance, or very little, can be placed on resemblances or likeness in the question of identity. We pass on, therefore, to the second question:—

Was it born alive? And how long did it live? We have already given most of the facts which will guide us in answering this question; they will be found at pages 768, &c. It is, perhaps, desirable to point out the systematic and proper way of examining the child's body in cases of suspected infanticide, and then to recapitulate briefly the *general* facts as to children who are still-born, and as to those who have been born alive and lived for some days. Before doing so, it is desirable, for the sake of saving a double repetition, to glance briefly at the—

Modes of Death in the Fœtus and in Young Infants, whether Natural or by Violence.

All the modes of death, or ways of dying of which we have spoken in chap. xx., p. 633, as common to adults, are also causes of infant mortality and of still-birth. There are, of course, certain circumstances [such as child-birth, and certain forms of violent and accidental death] which either cannot or will not occur to the fœtus, or new-born child.

The figures given by Tardieu of his own personal experience in the twenty-four years, 1844 to 1868, are of extreme interest, as in that period he had to examine 804 bodies of newly-born infants. Of these 231 were still-births (born dead), 18 died of intra-uterine diseases, or congenital weakness, whilst 555 cases of infanticide were thus divided:—

By suffocation .	281
„ immersion in privies	72
„ fractured skull .	70
„ strangulation .	60
„ drowning . .	31

By neglect . .	14
„ burns . .	8
„ wounds . .	8
„ hæmorrhage of navel	6
„ exposure to cold	3
„ poisoning . .	2
Total	555

As regards the causes of *still-birth*, or children being born dead, we must reckon (1) first labours (the proportion being 1 to 11 amongst primiparæ, and only 1 to 31·2 amongst pluriparæ, according to Dr. Lawrence ("Edinburgh Medical Journal," March, 1863); a large proportion of these primiparous cases being illegitimate. (2) The male sex in the proportion of 140 to 100, the births being only 106 males to 100 females. [Sir James Simpson, and Dr. Falck of Berlin, both agree in this, the proportions given by the latter being 56 males to 44 females, or 127·2 to 100.] (3) A large size of the head, most common in males, this rendering the labour a lingering one at best. (4) Premature birth, *see* remarks on Infant Viability, pages 748, &c. (5) Inherited diseases and malformations are self-evident causes. Dr. Taylor states, on the authority of the "British and Foreign Medical Review," No. 7, p. 235, from statistical tables, embracing eight millions of births, that 1 in 18 to 1 in 20 of all births are *still-born.* Dr. Lever found the proportion of 1 in 18 amongst 3000 births. So notorious is it that the larger number are illegitimate and first births, and that a very large number of these deaths could be averted, that the Society of Officers of Health in the metropolis strongly urged on the late Government to pass a Bill to render the registration of still-births compulsory, and to provide that all children whose bodies weighed not less than *two pounds*, the *average between the sixth and seventh months* (*see* table, p. 646), should not be buried without registration and medical examination, since at this age the children are viable.

There are many causes which affect the unborn fœtus, the child in birth, and the newly-born child. To separate the very few which are peculiar to each period, would be to be needlessly diffuse, regard being had to the scope and functions of this work. Nor will the term "newly-born" require lengthy discussion here. It is a term on which Continental laws, and jurisconsults, legal and medical, have differed, and perhaps will differ. As it has not (so far as we are aware) given rise to any discussion in our Courts, we shall assume that it is sufficiently well understood.* One of the most obvious, though not most common causes, is congenital malformations—such as those of the heart (leading to cyanosis, &c.); those of the alimentary canal at either end—for the gullet or the anus may be imperforate [Atresia pharyngis vel ani],—or the canal may be obstructed towards the middle, the duodenum being impervious for an inch or more. ["Medical Gazette," vol. xxvi., p. 542.] *Acardiac* or heartless monsters may at least live some hours. Monstrous children are usually very feeble, though acephalous ones have lived some weeks or months, and *dicephalous* ones grow up, as in the case of Mdlle. Christine. (2.) The following conditions of the *lungs* may prove fatal in very early life: *Red* and *gray hepatization*, from intra-uterine or acquired pneumonia; *pulmonary apoplexy; tubercles; œdema;* and Devergie's *œdema lardaciforme; atalectasis*, and *collapse of lungs* from fluid in the pleuræ. (3.) *In the brain and spinal cord* or *marrow*, softening, apoplexy, and effusions of serum or other fluids (such as pus or blood), and embolisms are most common. (4.) *Premature birth, protracted labour*, and *congenital debility*, with *hæmorrhages* from the funis or navel, or other parts may all cause death. Mr. Cullingworth, in "Liverpool and Manchester Medical and Surgical Reports," 1876, calls attention to the occurrence (though rarely) of hæmorrhage from the genitals in newly-born female children. He has collected thirty-two cases. The cause is probably either suffocation, or imperfect development of lungs. (5.) There may be *compression of the cord in birth* (as in breech and footling cases, &c.) or *knots may form spontaneously in the funis*, and the neck be compressed in this way, or the circulation in the cord be obstructed. [*See* Paper with illustrations by Dr. Read, "U. S. Amer. Journal Med. Science," Oct. 1861, p. 381. *See* also "Trans. Obs. Society," vol. iii., p. 413, case by W. Sankey, Esq., of Dover, who refers to "Smellie," vol. ii., p. 335, for an instance of a tight-drawn knot in middle of funis between eight and nine months of gestation. Vol. v. of the same "Transactions" contains [p. 25,] another case of a *double* knot. *See* also vol. xi., p. 54, for two cases, vol. xii., p. 133, and vol. xiii., pp. 187 and 51, and one of these (round the neck) is figured in vol. xiii.] Amputation of the limbs in utero is probably due to this in certain cases. [*See* Montgomery's "Signs and Symptoms of Pregnancy," *loc. cit.*, and Sir James Simpson's "Memoirs on Obstetrical Subjects."] (6.) Spasm of the larynx—or spasm of the muscles of respiration—tonic or clonic spasms (tetanic and epileptiform conditions—and paralysis of the vocal cords, &c.), may also prove fatal. (7.) Uric acid infarction, and probably uræmia, may occur at very early ages. In the former the kidney tubes are blocked with uric acid, or urates. Hydronephrosis is often, if not generally, congenital. (8.) There may be other congenital diseases—syphilis in utero—cancer, especially soft forms—and these may kill through the placenta; fatty, fibrous, and even mineral degenerations of the after-birth in the placenta being not very uncommon. (9.) Accidents, such as hæmorrhage from placental detachment, fractures of the skull in utero—and placenta prævia may also terminate fœtal life. We may therefore conclude with Dr. Taylor (from whom we abridge the following conclusions):—(*a.*)

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* A Brussels Court refused to call the murder of an infant fourteen days old *infanticide.* In Brittany a jury would not allow a child fifteen days old to be called newly-born (nouveau-né). The French Court of Cassation, in December, 1835, would not permit this name to be given to a child forty days old "attendu que la loi n'a eu en vue dans le crime d'infanticide que l'homicide volontaire commis sur un enfant *au moment où il vient de naître, ou dans un temps très-rapproché de celui de la naissance.*" Ollivier d'Angers thought the term *newly-born* appropriate only before the fall of the navel-string. Tardieu (*loc. cit.*) says that Robert Froriep of Berlin would revert to the terms of the old Roman laws:—"*Infans sanguinolentus, cruentatus,*" still soiled with blood. In Bavaria, a "newly-born" child is one not more than three days old (legal definition). In Brunswick and Saxony, twenty-four hours is the term. Werner and Gans define it thus: "It was new-born so long as it was neither fed nor clad, while the mother still laboured under the immediate conse-

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quences of the delivery, and while no one besides herself, her parents, and its father, knew of its birth."

The Roman law [Sect. 2, Cod. de patribus, &c. (IV. 43) speaks of "filium, filiamve *sanguinolentus*;" and Juvenal (Sat. vii., lin. 196) of a new-born child, "*a matre rubentem.*" Casper, *loc. cit.*, vol. iii., pp. 8, 9, &c.

That many illegitimate children are born dead from *natural* causes. (*b.*) Protracted labour, premature birth, congenital want of power to breathe, loss of blood before or after birth, and compression of the cord, may cause death before, at, or soon after birth. (*c.*) Malformation, or disease of important organs leads to the same result. (*d.*) But a strong healthy child may survive division of the cord without ligature, the vessels contracting, and a clot forming spontaneously.

A child may, and very often does, die of neglect during or after its birth. If care be not taken to prevent it, the child may be suffocated under the bed clothes, or fracture its skull by falling on the ground, or die of hæmorrhage from the cord having been cut, and not tied, or tied imperfectly. The theory of the law, however, as implied in the enactments respecting concealment of birth is, that—(notwithstanding exceptional cases of very strong hardy women, who might be able, as well as skilful, enough to attend to themselves and their infants)—no woman is competent at such a time to attend to her child, because she may be overcome by a sudden faintness, from pain or hæmorrhage, and that, therefore, she ought to inform others of her condition. It presumes that any married woman will know what ought to be done for a new-born child. And, therefore, when an accusation of child-murder (or infanticide) is met with the defence that the mother did not know what ought to be done, was faint, and perhaps delirious, &c.; it ought further to be proved that the woman was suddenly taken in labour, alone, and away from assistance. We may therefore include *neglect* amongst violent deaths, and proceed to discuss the other modes of infanticide. I. *We will first take the different forms of death by apnœa, or as it is commonly called, asphyxia.* Of these by far the commonest is, (1) *suffocation.* Infants just born can be very easily killed in this way. Even lying face downwards on a soft pillow is quite sufficient to destroy life at this early age. So are stuffing the bed-clothes closely round the new-born child, placing a wet cloth over its mouth, or stuffing a rag into the mouth, or thrusting the head into feathers, wool, ashes, dust, straw, or soft rags. Dr. Taylor speaks of death from the vapours of a privy or of burning sulphur [SO_2], and of chloroform vapour and other anæsthetics. These modes of death, however, though much resembling suffocation, are more strictly akin to poisoning. Particles of food may obstruct the wind-pipe, and block up its aperture (glottis), and thus induce suffocation. Even milk may be curdled in the stomach, and regurgitate into the pharynx and larynx, a mode of death which might be purely accidental—or the child might vomit, and, lying on its face, might draw the vomited milk, &c., into the air-passages, in an equally accidental way. This happened to a child one month old, reported by Mr. Ross of Guildford to Dr. Taylor (*loc. cit.*, p. 391). It has been suggested that the pressure of the vagina on the child's chest during birth might suffocate. This appears to us rather hypothetical.

After or during birth, pressure applied for a few minutes to the throat or chest, would certainly destroy life. The blood of the mother, or fœtal matters, such as meconium from the child, might also be sucked into the air-passages soon after the birth. *When a child is born with the membranes entire,* or with part of the membranes over the face and head, which is called *being born with a caul,* unless timely aid be at hand, the child must die. The Authors have met with cases in which the membranes were too tough to be torn by hand, and required incision. Mr. Blenkinsop of Warwick, in June, 1862, told Dr. Taylor of one such case in which a child was so born, and those present at the birth would not interfere. The Coroner held that as the evidence showed it had not breathed, it never had any legal existence ;—a "summing-up" which we have before shown to be incorrect. In Cormack's "Journal," Feb., 1845, Dr. Easton, of Glasgow, reports a case in which *mud* had evidently been forced into a child's throat and mouth, and was found in the gullet, as well as in the air-passages. *Straws* have sometimes been found in the stomach, &c., as in the case of *Macintyre* (Glasgow Autumn Circuit, 1829). Dr. Littlejohn reports a case of death from *dough*, or bread-pulp, forcibly impacted in the throat and larynx of a child—*the mass was accurately moulded to the parts* ["Edinburgh Medical Journal," Dec., 1855, p. 521]. In a case reported in the "Annales d'Hygiène, &c.," [1863, 2, 395], a plug of flax was found in the mouth. Foreign substances thus found in the interior of the child's body should be carefully examined; as in one case related by Dr. Dohrn ["Horn's Vierteljahrschrift," 1867, 2, 98, and Taylor, *loc. cit.*, p. 394], such an examination led to the mother's acquittal, as the truth of her account was thus substantiated. The child may be suffocated by being thrust into a small box or trunk, or prematurely buried.

If a child fall into a mass of fæcal matter, as in a privy, or similar public convenience, or even into the pan of a water-closet, the cause of death is generally suffocation, pure and simple, and not drowning properly so-called, as the quantity of water is generally small.

(2.) Suffocation by *strangulation* is a very common mode of infanticide. One of the commonest means, because always at hand, is the use of the navel string. As remarked at page 785, this may happen *naturally* from the funis being coiled round the neck in utero, and the child being so born, no skilled assistance being at hand, dies; and a suspicion of child-murder might thus arise. In such a case, however, there would be hardly any possibility of the lungs being aërated or expanded in the slightest degree, whilst if done after birth, some portions of the lungs would probably be expanded. Garters, bits of ribbon, pieces of tape, string, and portions of dress, may be, and all have been, used for the same purpose. It is but rarely that a new-born child is actually *hanged*, although such things have been.

In all the cases just mentioned, as in that of drowning, the post-mortem appearances are very similar. There will be the same congestion of the right heart, the same engorgement of the lungs, with punctiform and other ecchymoses on the pleuræ, pericardium, endocardium, peritoneum, and bronchial mucous membranes. Tardieu insists strongly on these in the case of death from any form of suffocation; and he has given an excellent coloured plate of these extravasations of blood, which are usually bright in colour, whilst the rest of the blood, in the lungs and right heart, and in the veins, is very dark. Dr. Taylor quotes Drs. Douillard and Gallard ["Ann. d'Hygiène," 1872, vol. i., p. 201], to show that sub-pleural ecchymoses may be found in death from natural causes. Dr. Ssabinski ("Horn's Vierteljahrs.," 1867, vol. ii. p. 146) states that he only found these ecchymoses once in ten cases of animals suffocated. This observer thinks a bloodless condition of spleen a more constant symptom. Our own experience, however, agrees with that of Tardieu; *and we have* *already cautioned you against placing undue reliance on any one sign or symptom taken by itself alone.* There is, however, one great difference between the lungs of young children and those of aged adults as regards suffocation. If the child be vigorous and well-developed, the muscular and elastic forces of the arteries and arterioles will be sufficient to drive the blood on after the heart has ceased to beat, and respiration is prevented. Such lungs will therefore be often found comparatively bloodless, or anæmic, but with a large amount of emphysema, or dilatation and rupture of the air-cells, owing to the violent attempts at inspiration or breathing. Some years ago the authors were somewhat puzzled at discovering these results of the vitality of the tissues. There could, however, be no doubt as to the facts, as they were found in accidental cases where the suffocation was undisputed and fully proved. Since these several continental medico-legists have pointed out this phenomenon in the lungs of young children. For other post-mortem appearances, reference must be made to the chapter on "Death by Apnœa" (asphyxia).

(3.) *Death by drowning.*—Just as in the case of suffocation, if a child have never breathed, it would be impossible to show that death resulted from drowning. But the body, if it had been long in the water, would exhibit the phenomena of *maceration.* The fact that a child had *swallowed* dirty water, with shells of minute size, sea or water-weeds, sand, mud, diatoms, and the like, would be strong corroborative evidence. [*See* the chapter on "Apnœa and Asphyxia," section "Drowning.")

Adipocere would take at least four to six weeks for its formation.

Remember that to prove fatal the whole of a child's body need not be submerged or under water.—To use a common phrase, a child of small size might be drowned in a quart-pot. It is quite enough for the face, indeed for the mouth and nose, to be completely covered by water. It is often said that a body is merely thrown into the water to get rid of it, after the child is dead. You will, therefore, have to search for signs of live birth, and to see whether the child have survived its birth some days or not. Children newly born are often found in privies or water-closets; and the defence generally adopted is, that the mother was suddenly taken in labour whilst sitting on the closet. If you find proofs that the child has survived its birth some days, such a defence is at once invalidated. For this mode of defence to be established, it ought to be proved either that the pelvis was very large, or that the child was very small, or the final act of delivery very rapid, and that the mother lost consciousness. It would appear from Taylor (and this agrees with our own experience) that the condition of the funis, or unbilical cord, will very often settle the truth or falsehood of such a defence at once.

II. *The infant may have died from wounds.*—We need scarcely point out that the discovery of punctured, incised, lacerated, or contused wounds, must always lead to the gravest suspicion of murder. For although the use of obstetric instruments, the scissors used to divide the cord, and broken utensils, might all inflict such wounds; yet, as a matter of fact, except from the former cause, such injuries are almost unknown. The marks of forceps, or of craniotomy instruments, are too familiar to practical men to need detailed description.*

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* Usually speaking, the mark of one forceps-blade is in *front* of one ear, and

The only accidental injuries produced by a careless division of the funis of which we have personal knowledge happened to the fingers in one instance, and to the penis and the toes in the others.

For the answer to the question, "Were these wounds inflicted whilst the child was alive?" we must refer to the chapter on "Wounds."

Lingering labours, especially when there is much difficulty in the passage of the child's head, produce a puffy and blood-infiltrated swelling of the child's scalp, known as *caput succedaneum*, or *cephalhæmatoma*, which is familiar to all practical accoucheurs, and even to midwives.

III. *Fractures of the skull and other bones.*—The bones of the skull, and particularly the parietal bones, are most likely to be broken, both by accidents, and by violence, employed with criminal motive. It is true that a clumsy midwife (like the one who said, "I always breaks the child's legs in these cross-births") or accoucheur might fracture the bones of the arms or legs by dragging down the former across the child's back, or by undue force applied to the latter. It is to be hoped that such cases are now extremely rare. In any case, this injury is hardly likely to be immediately fatal. Fractures of the skull, and of other bones, such as the ribs, or those of the upper or lower extremities, may happen accidentally in two ways, viz. :—

(1.) *Accidents happening to the mother before the birth of the child may produce intra-uterine fractures.*—A fall down stairs, kicks on the abdomen, or violent blows, may fracture the child's skull, ribs, or limbs whilst unborn. The authors have known this to occur in the sow, bitch, and doe-rabbit, as well as in the ewe and the female cat, from their being run over. A mare in foal fell over into a quarry, and the colt with which she was heavy, was born dead with a fractured skull. A costermonger kicked his donkey, who was near her time for foaling—the young donkey had a broken fore-leg, and symptoms of fractured skull. Dr. Stanelli ("Gazette des Hôpitaux," Nov. 7, 1846, p. 523), states that a pregnant woman, five days before the expiration of her full term of pregnancy, fell whilst running, so that her belly struck sharply against a jagged stone. Four days after she was delivered of a dead and putrid child, and she herself died in an hour. The child's head was greatly swollen, and the skull was found almost crushed, the parietal having become separated from the temporal bones as if by external violence. There were no other injuries except those of the skull in the child. *See* Taylor (*loc. cit.*, p. 413), and Dr. Barker, of Bedford, "On Intra-uterine Fractures," p. 21, 1857. Tardieu reports a case of fracture of a child's skull by the mother falling out of window whilst in the very act of labour! (*loc. cit.*, p. 134, *see* also H. Blot, "Bull. de la Société Anatom." xxiii. année, 1848, p. 198.)

(2.) *Fracture of the skull, &c., may occur in the act of birth from the child falling on the ground.* It is well known that the usual *presentation* or *position* of a child in utero, is head foremost. There are now so many instances of this accident on record in all the modern works on legal medicine, and in most of those on obstetrics, that we think it enough to mention the fact, and to add, that we have known it occur where

that of the other blade *behind* the corresponding ear. Strange as it may seem, we have known the professed pathologist (of a large hospital) forgetful of the appearances usually produced by craniotomy, done with scissors and crotchet. He described these appearances as resembling the ravages of a carnivorous animal!

there was no suspicion of child-murder—that it is most likely to happen in women with large roomy pelves (pelvis equabiliter justo major), such as are exceedingly common amongst Irishwomen, and healthy women in country districts—or when the child is prematurely born. The fracture is most commonly, but not of necessity, of the *left* parietal bone. The site being determined partly by the presentation, partly by the position and movements of the mother. Consult on this subject of fractures, Taylor (*loc. cit.*), p. 403, &c., also the "American Journal of Medical Science," January, 1853, p. 254; also "Hartshorne's Medical Jurisprudence," American edition. Tardieu (*loc. cit.*), p. 133; Schwörer, of Freiburg, Beyträge zur Lehre von dem Thatbestande des Kindermordes, &c., &c., Freiburg, 1836, p. 38; also Casper's "Medical Jurisprudence," vol. iii. Dr. Balfour's translation.

(3.) *The use of the forceps*, or other obstetric *instruments* may cause fracture of the skull. Tardieu figures such cases. Taylor and Guy allude to them. The remark previously made applies here, that the marks of the forceps are most common just in front of one ear, and just behind the other. The parietal and temporal bones are those most likely to be affected. Version may sometimes be a cause of fracture.

(4.) *It has been said that the woman's hands, the force of the uterus itself, of the vagina, or of the woman's thighs*, may fracture the skull of the child in the act of birth. Practical accoucheurs know very well that in difficult labours, quite apart from any use of instruments, the bones of the child's skull become folded over one another, which can only happen by their becoming partially severed from each other. Sometimes there is an audible crack or grating to be heard under these circumstances. It is not to be doubted that the mother's hands, or even thighs, may exercise an enormous force. What seems to have been forgotten is, that very much depends upon the degree or amount of ossification in the child's skull. The more mature, the more likely to be fracture. When we are asked, however, to go a step further, and to believe that the neck can be dislocated, or the head severed in a healthy new-born child, whether living, or only just dead, without any undue violence, we must hesitate, when we know that Dr. Matthews Duncan estimated that a traction force of 105 lbs. can be applied to a child's neck without destroying life, and that at least 120 lbs. force was required to sever the head of a new-born child. Joulin has even applied 148 lbs. traction force to the neck of a dead fœtus without separation. Gordell again has seen a child born alive after 130 lbs. traction force, and has twice known living children born after an audible crack. ["British Medical Journal," Sep. 19, 1874, p. 384; "Dublin Quarterly Journal of Medical Science," Nov. 1875, p. 445.] Where there is previous death and decomposition, the head may, no doubt, be pretty easily severed, and may sometimes be left behind in utero, in breech and footling cases. The authors themselves know of such cases—and they are mentioned in most obstetric works. As regards the traction-power, it is well known that a man of 10 stone has repeatedly pulled with all his might without this result; and although only a portion of his muscular force, and a portion of his weight can be supposed to act in a straight line with the neck, there can be no doubt the force employed is often enormous. *All the fractures of the skull to which we have just alluded are, as a rule, much slighter and less marked than those produced by intentional violence.* This is true even of the forceps cases, and of those produced by falls from a height. As regards the possibility of a woman being delivered in the upright position, besides the numerous cases related by Casper and others, the authors can add their personal experience. One such case happened suddenly to a lady who was exceedingly anxious to have a living child, having had several dead ones. It is, however, very seldom that such falls prove fatal to the child—if it dies there is generally some other cause of death. Besides fracture of the skull, such as sudden birth and fall may cause the cord or funis to be suddenly broken off [this is not always so, much depends upon its length, as well as strength]; premature separation of the placenta with its results; concussion of the brain, and hyperæmia of and within the skull, or actual cerebral hæmorrhage in various situations; Ploucquet says dislocation of the cervical vertebræ [?] and possibly other fractures, as of the limbs or ribs. *Fractures of the skull from violence*, purposely inflicted, are usually far more severe. The skull is often battered in with fearful violence, and it is seldom that the seat of injury is confined to any one spot. There are usually several fractures, and other signs of violence. We need scarcely caution you against mistaking natural deficiencies in ossification for the effects of violence.

IV. *Poison is sometimes, though rarely, employed to destroy the new-born child.* Opium is most likely to be employed in this way—either in the form of syrup of poppies, or laudanum, or some of the "soothing syrup," too much used to quiet infants. Tardieu remarks that this mode of infanticide is very rare. In a recent case of suspected infanticide near Finsbury Square, it was stated that an overdose of syrup of poppies had been given by mistake (!). As the body of the child had been boiled, it would have been difficult to detect this poison. Slingenberg ["Dissert. Medic. forens. de Infanticid," Gröningen, 1834, p. 99], quoted by Tardieu, states that in one case known to him, orpiment was given to the new-born child by the mother to kill it; and in another case verdigris. Tardieu mentions two very young infants who were destroyed by the introduction of sponges dipped in nitric and hydrochloric acids respectively into their mouths. This crime would appear (from Taylor and Tardieu's reports) to be more frequent in France than elsewhere. There is no special difficulty in detecting poison in the bodies of young infants —and in any doubtful case, it would be your duty to examine for evidence of this sort of death.

V. *Newly-born children may be killed by cold and exposure.* This is, of course, most likely to happen in the winter months. The evidence must be chiefly circumstantial. It is well known that a young child requires more warmth, ab extra, than an older child or a young adult.

VI. *Death may have been caused by starvation.* A healthy, mature child, if kept warm, will generally live two or three days without food, or with very little. If, therefore, death occurs from this cause, it will be almost certainly of set purpose. The empty condition of the alimentary canal would be the chief medical proof. See the chapter on Starvation.

VII. *The child may die from burns and scalds*, purposely inflicted. The questions likely to arise out of these injuries are precisely the same as in the case of adults, viz.: Was the burn or scald inflicted during life? or after death? If the former, was it mortal? We must refer to the chapter on this subject for the general principles which must guide you in forming a judgment.

On the condition of the Mother during or just after Childbirth.

Those accoucheurs whose practice is chiefly among the middle or upper classes, or amongst well-to-do artizans' wives, are very apt to underrate the strength, capacity for endurance, and muscular exertion of the parturient or recently delivered female. The habits of savage nations in this respect are well known. An Indian or African woman, or even a gipsy, will step aside into a wood, be delivered of a child without assistance, and then resume her march with the tribe she is accompanying. Even in our own country, there are numerous instances of domestic servants and field-labourers resuming their work immediately after childbirth. One of the authors saw a country-woman doing heavy field work, on a wet day, on a clay soil, the day after the birth of her ninth child. In another case, a primipara, after delivery accompanied with profuse hæmorrhage, dropped down from a window twelve feet from the road, and walked at least eleven or twelve miles, and was apparently but little worse for it. Casper and Taylor, and other authors on this subject, relate similar instances. You should also be aware that it is by no means a rule without an exception for a first labour to be a lingering one. A great number of cases of sudden delivery have occurred in primiparæ, and that in circumstances quite free from suspicion.

The Duties of Experts, in cases of suspected Infanticide.

These are so well explained by Beck that we cannot do better than quote him with slight alterations as regards,—

I. *The examination of the child.*

(1) As regards the external examination this should embrace the following particulars :—

- (*a*) Everything relating to its external appearance, shape, conformation, condition as to putrefaction, spots, ecchymosis, &c., &c.
- (*b*) Its size, including not merely the length, &c., of the whole body, but the dimensions of the head and thorax.
- (*c*) Its weight.
- (*d*) The condition of the navel and umbilical cord.

II. *Internal examination.* This should include,—

(1) The condition of the respiratory organs.

- (*a*) The dimensions and shape of the thorax.
- (*b*) The situation of the diaphragm.
- (*c*) The colour of the lungs.
- (*d*) Their volume.
- (*e*) Their shape.
- (*f*) Their situation.
- (*g*) Their consistence or density.
- (*h*) Their absolute weight.
- (*i*) Their specific weight.

(2) The condition of the organs of circulation.
  (*a*) The foramen ovale.
  (*b*) The ductus arteriosus, its dimensions and shape.
  (*c*) The ductus venosus.
  (*d*) The state of the umbilical vessels.
  (*e*) The condition of the heart and its cavities (this must be noted first).

(3) The condition of the abdominal organs.
  (*a*) The liver, its weight and size.
  (*b*) The stomach and intestines; particularly the large intestines; as to the presence or absence of food, meconium, &c.
  (*c*) The state of the urinary bladder and kidneys.

(4) The condition of the brain and spinal marrow, the cranium having been first examined for fracture, &c.

In opening the body of such a child, Beck recommends that an opening be made from the mouth downwards, and that the symphysis of the lower jaw should be divided, or portions taken out so as to get a clear view of the throat and mouth. If, however, the mouth be forced open, and the plan recommended at page 10, for making post-mortems be adopted, it will seldom be necessary to divide the lower jaw.

III. As regards *the examination of the mother*, or we should rather say of the woman suspected of having given birth to the child, we have little to add to what has been already said of the signs of recent delivery in the living. Should she be dead, the remarks made at page 706 will apply.

IV. *You may be called upon to examine bedding, articles of wearing apparel*, and perhaps *stains on the floor of a room, or water-closet.* The peculiar smell of a lying-in-room, the discovery of fœtal hairs, meconium, and perhaps fragments of decidua, or portions of placenta and of the membranes will be almost the only signs on which you can place absolute reliance. For blood might arise from menorrhagia, uterine hydatids, metrorrhagia, from fibroids or polypous tumours of the uterus, and the like; or, as in a case which occurred a few years ago, from a "sheep's pluck," procured to represent the placenta!

On Medico-legal Reports in cases of Infanticide.

Most authors, on the subject of infanticide, give examples of the kind of reports which a medical witness, or witnesses, should draw up in such cases. Although our own opinion is that an intelligent medical witness will generally find but little difficulty in writing down the facts he has discovered in his examination, we think the subjoined form may prove of advantage, because it enables us to repeat some of the principal facts on which our decisions must be founded. We have chosen a case of a newly-born infant, who had survived its birth some days, and had been suffocated.

I, [*or We*], the undersigned, [John William Smith *and Thomas Brown*] Doctor of Medicine [or Member[s] of the Royal College of Surgeons, *and* Licentiate[s] of the Society of Apothecaries], residing at [920, *City Road, N.*], and practising as Physician[s] [*or Surgeon*[s]], hereby declare, as witness my [*or Our*], hand[s] and seal[s], that being requested to examine the body of a male infant, found on the 20th July, 1876, in [a goods-shed of the London and North Western Railway Company], I, [*or We*], accordingly did so on the [21st] day of [July 1876], and that the following account is a true statement of the facts of the case:—

The body is that of a well-developed and mature male child, born at full term, as is shown by the facts. Its length is [20½] inches. It weighs [7¼] pounds. The head measured [3¼ × 4¼ × 5] inches. The nails are well developed and nearly reach the ends of the fingers. There is a good deal of hair on the head—these hairs are about ¾ of an inch long. Both testicles [or stones] are in the scrotum [or purse]. The pupillary membranes have been fully absorbed. There is not much hair on the trunk. The navel was as nearly as possible the middle point of the child's length. The navel string had been tied and cut off at a distance of 2¾ inches from the body. It had completely withered, and had almost separated from the body. There were no signs of external injury, except that around the mouth there were marks such as would be produced by a coarse towel or cheese-cloth, firmly pressed down upon the flesh—namely, longitudinal and transverse markings, intersecting one another, such as the warp and woof of a coarsely woven fabric would produce. The extremities, that is, the tips of the fingers and toes, especially the nails, and the ears and nose, were extremely livid or dark —exactly as happens in the case of death by suffocation. On opening the body, I, [*or we*], found as follows:—The lungs nearly filled the chest. The diaphragm reached as high as the [sixth] rib. The right heart was loaded with dark blood. The left side of the heart was empty. The *foramen ovale was nearly closed*, and the *ductus arteriosus* was funnel-shaped and closed at the end nearest the aorta, or chief blood-vessel. The pericardium [or bag containing the heart], and the pleuræ [or bags containing the lungs] were marked with bright star-shaped patches or extravasations of blood. So also were the lining membranes of the bronchial tubes, and of the interior of the heart. The lungs weighed [1120] grains. The edges of the lungs were emphysematous, in other words, the air-vesicles were distended, bloodless, and broken down one into the other. The air-vesicles of the rest of the lungs were plainly visible to the naked eye, and some portions of both lungs floated in water. The remainder of the lungs were gorged with blood, which escaped freely, mixed with froth, when they were cut into. These portions sank in water, although not quite to the bottom of the vessel. The bronchial tubes contained frothy mucus mixed with blood. There was nothing remarkable in the abdomen, except that all the organs, and all the veins were distended with dark blood. The umbilical arteries had closed. In the stomach we found a quantity of starchy food [probably arrow root], with some milk, and in the large intestines some fæcal matter of brownish colour. The point of ossification of the lower epiphysis of the femur was three lines in diameter. On opening the head, we found the membranes of the brain much congested—the sinuses filled with dark blood. There were numerous bloody points in the brain substance. The brain weighed 10¾ ounces. The liver weighed 3 ounces. From these appearances I, [*or we*], conclude—

1st. That this child was born at full term, and alive.

2nd. That he survived his birth some days—probably a week at least.

3rd. That he died, in all human probability, from suffocation, such suffocation being most likely purposely done with a coarse damp towel or cheese-cloth—the marks of the fabric on the lips and round the mouth being coarser than those caused by the linen or baby-clothes generally in use.

Further, the said [here insert the name or names], further declare that I [or we] have also examined a woman aged about [twenty-two years], whose name was said to be [Amelia Jones], whom we found in bed at [890 *Bath Street, City Road, E.C.*] She had dark circles round her eyes. The pulse was weak and compressible, and over 100 [106] per minute. The skin, &c., of the belly or abdomen was relaxed, flabby, and wrinkled. It was marked with numerous shiny streaks [lineæ albicantes] and purplish marks; these were also found on the thighs. A body in the situation of the uterus could be felt through the abdominal walls, as large as a cricket ball, or somewhat larger. There was milk in both breasts, and a dark circle [areola] round each nipple, in which numerous and large follicles could be seen. The perinæum was torn for about half an inch towards the anus, but not extending into it. The vagina was much relaxed, and had a bruised and dark appearance. The uterus felt large and heavy. The os uteri was wide open, and admitting two fingers, presented three or four distinct lacerations, or tears. A sound could be passed to a depth of nearly 5 inches. The under-linen, bedding, &c., were stained with blood, and she had a greenish yellow [lochial] discharge. From these appearances I [*or we*] conclude—

1st. That this woman has been recently delivered, and that probably within a week or ten days.

2nd. That looking at the lacerations of the perinæum and os uteri, the child of which she was delivered was in all probability mature and of full size.

3rd. That it is therefore probable, as she will give no account of her own child, that the body found is that of said child.

In witness whereof, I, [*or we*], have hereunto set my [or *our*] hand[s] this [21st] day of [July], 187[6].

In drawing up such reports, attention should be paid to the following particulars:—

(1) All measurements and weights and statements of size should be in plain terms, and as far as possible in standard measures and weights —or comparison made with well-known objects.

(2) Dates and places should be plainly stated, and also names of persons where such are known.

(3) The conclusions or opinions should be kept distinct from the facts.

Cautions as to the Docimasia pulmonum or examination of the lungs.

Although we have before stated that breathing or respiration is not the only proof of life, yet there can be no doubt that the examination of the lungs is the chief means of establishing the fact that a child has had separate life. It is therefore very necessary that we should have clear ideas on this subject. We therefore recapitulate very briefly, in a tabular form, the characters of lungs which have, and have not, respired or breathed :—

Lungs which have *not* breathed.	Lungs which have breathed.
1. Dark in colour [black blue, maroon, or purple]. They resemble liver.	1. Light in colour [rose-pink, paler pink, light red, or crimson].
2. Air-vesicles not visible to naked eye.	2. Air-vesicles distinctly visible to naked eye, or to lens of low power [say a 2 inch, or common reading-glass.]
3. Do not crepitate or crackle when squeezed or cut.	3. They crepitate, or crackle freely.
4. Contain but little blood—therefore little escapes on section.	4. Contain a good deal of blood, which escapes freely on section.
5. This blood is not frothy, unless there is putrefaction.	5. This blood is freely mixed with air, and therefore frothy.
6. They sink in water, unless putrid, and often even then.	6. They float in water, or, at all events, the parts which have been expanded, or have breathed. If fully expanded, they will even buoy up the heart.
7. The bubbles of gas arising from putrefaction can be squeezed out.	7. The air cannot be squeezed out.

We have previously alluded to some of the supposed fallacies of the *hydrostatic test* or floating of the lungs in water, but in reality, if (1) we take care that the water is cool [not above 62° Fahrenheit], if (2) we remember to cut the lungs into pieces if the whole do not float, and if (3) we *combine pressure* with the floating ;—there is in reality no fallacy except the difficulty of distinguishing cases of artificial inflation [which may have been done by mouth-to-mouth insufflation, or by Marshall Hall's, Sylvester's, or any other method of artificial respiration, such as passing a trachea-tube],* from those of natural breathing. We suppose it must be conceded that it is not possible to distinguish by any certain tests, the differences between lungs naturally expanded by breathing, and those artificially expanded by breathing into them, or other means of artificial respiration [often called *inflation*]. Though, as a generally true statement, it may be said that *Lungs artificially inflated* are almost *sure to be emphysematous* in a far higher degree than is probable in lungs of the newly born which have not been so treated.† We have therefore only to repeat the following cautions :—

1. Remember that disease [Atalectasis, &c.], or imperfect development may prevent the proper expansion of the lungs, and that it has been proved that a child may live some hours, or perhaps even a few days, and yet nearly the whole of both lungs may sink in water, and—

2. Remember that proof of respiration does not necessarily prove that

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* This instrument was so often passed into the pharynx, or gullet, instead of into the larynx, or windpipe, that it is now pretty generally omitted from the Obstetric Bag, or case.

† Casper says, "When, therefore, we observe the following phenonema : A sound of crepitation without any escape of blood-froth on incision, *laceration* of the pulmonary cells with hyperæmia, *bright cinnabar red* colour of the lungs *without any marbling*, and perhaps, *air* in the (artificially inflated) stomach and intestines, we may with certainty conclude that *the lungs have been artificially inflated*."

the child was fully born in the legal sense, or completely separated from its mother; and—

3. Do not profess to distinguish with absolute certainty between artificial inflation and natural breathing.

General Conclusions.

1. It is possible by inspection, incision, the hydrostatic test, and pressure combined, to say whether a lung has been expanded or not, and such expansion is in ninety-nine cases out of a hundred, a proof of respiration.

2. Putrefactive changes, emphysema, and the effects of disease can be recognised and estimated with comparative ease: the smell, large size of the bullæ, colour of the lungs, and chemical tests, such as lead-paper, all rendering it difficult to mistake the changes produced by putrefaction when ordinary care is taken.

3. Atalectasis pulmonum and other diseases of the lungs generally occur in feeble and premature children, who are under size and under weight.

4. A careful examination of the child's body and of its surroundings will generally enable us to ascertain its age, degree of development, and whether it has met with its death by disease or accident, or by criminal violence.

5. Whilst agreeing with Casper that the examination of the lungs is superfluous in the case of very premature fœtuses (as before the fifth month), before they are *viable*, and also in cases of *children born putrid*, we do not agree with him that it is superfluous to examine the lungs when there are proofs of survival of birth from the condition of the cord or navel, or of the stomach and abdomen. On the contrary, this accumulation of proof is exactly what a medical witness in this country wants; to be "armed at all points," so as to be perfectly unshaken in his evidence by any legal subtleties.

Signs of Putrefaction before Birth.

Dr. Guy (who has done good work on the question of infanticide, and especially in regard to the examination of fœtal lungs, and the importance of looking for the air-vesicles), describes at pages 81 and 82 of his work on Medical Jurisprudence the symptoms of intra-uterine maceration of the fœtus, and gives a figure of a fœtus in which this soaking in the womb had gone so far as to loosen a great part of skin. He objects to the term putrefaction, because in many of these cases there s little or no smell. We think, however, that the smell has been there, nd that the term putrefaction is still applicable. We therefore take from Casper his graphic description of these changes [Dr. Balfour's translation, p. 91, vol. iii.] He says:—"*It is impossible to mistake the ppearance of a child born putrid.* The swollen *cutis*, the vesicular elevation of the cuticle or its complete peeling off, the greyish-green colourtion of the body, the putrid navel-string, the well-known stench, &c., o not constitute the diagnosis, since every child, even when born alive, ndergoes these putrefactive changes in their turn at the proper time fter its death. On the contrary, most of these characteristics are not xhibited by a child born putrid, and the putrefactive maceration in the warm liquor amnii is so very different in its operation from putrefaction external to the uterus, that it produces an appearance so specific as to be unmistakably recognised whenever it has been once or twice seen. In the first place, a child born putrid is remarkable for its penetrating stench, which cannot be concealed by a thin coffin or chest, &c., and which, though so repulsive and indestructible, is not yet the usual well-known odour of putrefying bodies, but has something sweetish, stale, and indescribable about it, which makes it all the more unendurable. The difference in the general colour of the skin in the two classes of children is still more remarkable. A child born putrid has not a shade of green upon its skin, but is more or less of a coppery red, here and there of a pure flesh colour. Peeling of the cuticle is never absent, but close to recent patches of this character, older ones are found upon the body, the bases of which are already dark and hardened. The excoriated patches are moist, greasy, and continually exude a stinking, sero-sanguinolent fluid, which soaks through all the coverings of the body. The general form of such bodies is as remarkable as their colour. Whilst every highly putrefied corpse preserves for long the roundness of the contour of the body, though its form is disfigured and distorted by intumescence, it must strike every one when a child born putrid is placed before him, how great a tendency is displayed by it to flatten out, and as it were, fall to pieces. Thorax and abdomen lose their roundness, their contour forms an ellipse, from the soft parts sinking outwards towards both sides. The head itself, the bones of which are loose and moveable as in every child's body, becomes flattened, and the face thereby repulsively disfigured, as the nose is flattened, and the cheeks fall to opposite sides. It is impossible accurately to describe the appearance of such a child, and it is not worth while to append an exact representation true to nature, since the sketch here given, as accurately as possible, is sufficient to characterise a child born putrid."

Long maceration in a warm and weak saline fluid [the liquor amnii at a temperature of 37° or 38° centigrade] is the chief cause of these appearances. *If a new-born child's body be boiled*, as in the case of an infant whose corpse was found near Finsbury Square, the appearance is correspondingly altered, and bears a striking resemblance to boiled pork or veal. *Long maceration in sea water at a high temperature, as in summer weather*, provided the body be covered from the sun, or exposure to air, produces similar effects to those of intra-uterine maceration, except that it is likely to be more changed into adipocere, and that the colour of the lungs, in one case at least, resembled that due to aëration [*See* "London Hospital Reports," vol. i.].

In actions for bastardy and the maintenance of illegitimate children as well as in suits for *crim. con.* in the Divorce Courts, and, indeed, in all trials involving the relations of the two sexes, there will often be most ridiculous as well as disgusting statements made on both sides. Casper's third volume will give many examples. We must, however, warn you against lending the aid of medical authority to any views on these subjects, which do not rest on a sound basis. For example, a man with well-formed sexual organs will ask you to certify that he is impotent, and gravely point to a very slight degree of phymosis, to a miniature wart on the penis, or a slight varicocele, or, perhaps, congenital shortness of the prepuce, as *evidences* of his statement. And women will coolly exhibit the results of chronic disease, and of long-continued sexual intercourse as the effects of recent violence. One golden rule will save you from being led away by such errors—viz., *Never certify the statements of others as facts.* Found your reports only on what has been observed by yourself, and keep your opinions and conclusions, although founded on such facts, perfectly distinct from them. Let plaintiff or defendant make their own statements as they like. You have the credit of the medical profession, you have your own reputation, and the interests of truth to maintain. No temporary gain, whether of fame or money, will compensate you for forgetting these interests.

Illustrative Cases.

Before giving these, we insert a couple of explanatory figures, to render the cases more easy to understand.

FIG. 106.

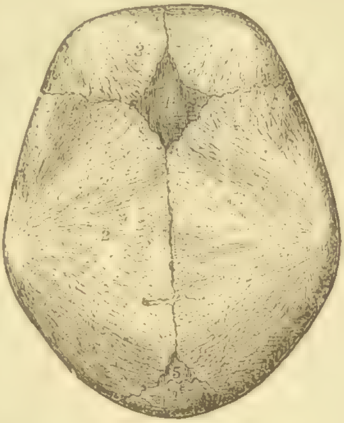
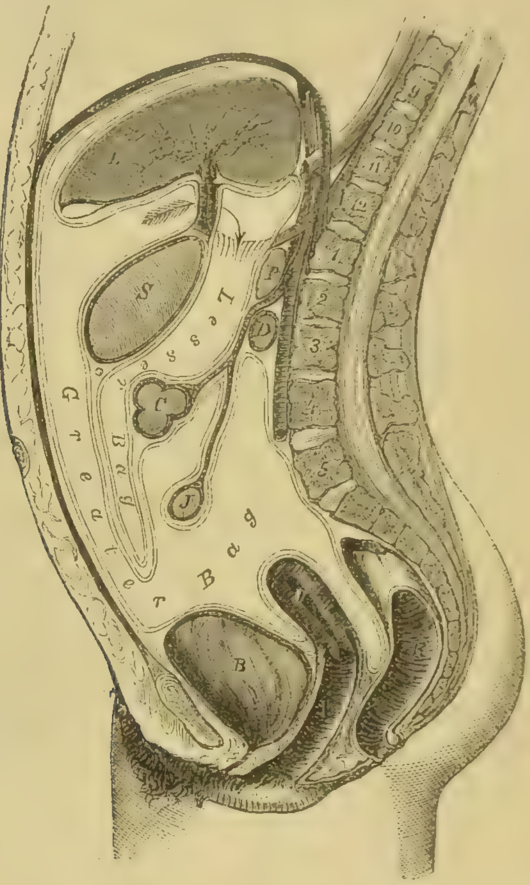


Fig. 106 shows the fœtal skull. 1 is the *occipital bone,* 2 the left *parietal,* 3 the left half of the *frontal* bone (which is double in the fœtus and young child, being developed from separate centres, though forming one bone in the adult), 4 is the *anterior fontanelle* or *bregma,* where ossification is deficient. In rickety children this is sometimes still "open" or unfilled by bone up to two or three years of age, or even more. 5 is the *posterior fontanelle* or *bregma ;* between these two is the *longitudinal* or *sagittal suture,* separating the two frontal bones. At 5 commences the *lambdoidal suture,* whilst the *coronal* is seen running across the front in the same line as 4 (separating 2 and 3 on the left side.)

Fig. 107 shows the arrangement of the internal organs, and the reflexions of the peritoneum in the female. 9, 10, 11, 12, are dorsal *vertebræ,* 1, 2, 3, 4, 5, lumbar ditto. Below these, five pieces constitute the *sacrum,* the rest of the backbone being called the *coccyx.* The *promontory of the sacrum,* so often mentioned in obstetrics, is just below the 5. B. is the urinary bladder, represented as full, and therefore rising above the *symphysis pubis,* seen just in front of it, V is the vagina, *U* he *uterus* or *womb,* R the rectum, J is the jejunum (part of the small ntestine), C the colon, D the duodenum, P the pancreas, S is the tomach [the spleen is not shown, but would be close to the left side of his], L is the liver. The arrow seen between S and L shows the foramen f Winslow, communicating between the lesser and greater bags or avities of the peritoneum. This membrane lines the whole interior of he abdomen, and more or less closely invests the whole of the viscera. n front of the stomach it descends to form the great *omentum* or *caul* y again ascending to invest the intestines and posterior walls of tomach. It will have four thicknesses here, as it is like the pleuræ nd pericardium, a closed cavity, and invests the various organs for the most part like a double night-cap, though one layer is parietal (or belonging to the abdominal walls), and the other visceral (or belonging to he viscus or organ covered). It will be seen on a reference to the gure that the *pelvic organs* (bladder, uterus, rectum [and ovaries, not shown in this figure]), are only partially invested or covered with peritoneum, in other words, on their upper surfaces. This is of considerable importance in obstetrics, and also in operative surgery, on account of the great liability of the peritoneum to severe and often fatal peritonitis. Operations done without implicating this membrane (as lithotomy in the distended bladder, ablation and incision of the os and cervix uteri, and operations on the lower end of the rectum, are therefore comparatively safer than those requiring the peritoneum to be opened, such as ovariotomy, gastrotomy, operations for relief of strangulated herniæ, intussusception, &c.]

FIG. 107.



Case I. *Suspected Infanticide. Difficulties from Putrescence.* [Casper, *loc. cit.*, Case CCCXLII.]

"A mature male child was found in the water, enclosed in a bag loaded with stones. The body was green from putrescence. There were many gaseous bullæ in the lungs, the result of decomposition; the left lung was completely retracted, the right one filled about one-half of the pleural cavity. No crepitation was heard on making incisions into the lungs, and a little fluid blood flowed out of the cut surfaces. They floated together with the heart, but the heart itself, the whole lower lobe of the right lung, and isolated portions of the left one, sank. The liver, however, floated. The diaphragm was at the fourth rib. The trachea was empty and brown from putridity. The stomach contained a teaspoonful of bloody mucus. The bladder was empty, the rectum filled. The partial floating of the lungs might very reasonably be ascribed to their state of putrescence, yet, though several very important symptoms pointed to the likelihood of the child having been born dead, it was impossible to deny that respiration might possibly have been temporarily established. Accordingly [says Casper], we gave it as our opinion that the child had 'probably' not lived subsequent to its birth, but had been born dead."

We quote this case first, as an excellent example of the caution which an admittedly great authority exhibited in such matters.

CASE II. *Another Case of a similar nature.* [Casper, No. CCCLII.]

"A new-born female child was found firmly sewn in a sack, and lying in the street during the heat of summer. It was unquestionably mature (20 inches long, 6¾ lbs. weight, &c., &c.), the osseous nucleus was only 2 lines in diameter, the body of greyish-green, the cuticle almost entirely peeled off. The diaphragm was placed at the seventh rib. The liver was black, strewn with large gaseous bullæ, and floated. The spleen and kidneys were pultaceous, the stomach brownish-red from putrefaction, and empty. The urinary bladder was empty, there was a quantity of meconium in the large intestine and rectum. The vena-cava was empty. The lungs completely filled the thorax, were of a dirty, livid rosy-red and marbled, thickly strewn with many gaseous bullæ. They crepitated strongly under the knife, and in spite of the great general putrefactive anæmia, there was a distinct escape of bloody froth from the incisions. The lungs floated perfectly. There was a *caput succedaneum;* not a trace of any injury." Casper gave it as his opinion that this child had lived. He could not, however, say how long, except that it could not have been many days after its birth, which was indubitable.

CASE III. *Death of a Child from Apoplexy, after a Forceps Labour* [Casper, Case CCCLXV.]

"In this case there was no suspicion of infanticide, and the post-mortem signs are therefore all the more valuable. This mature male child was delivered by forceps after a severe labour, and shortly after died from apoplexy. The traces of the forceps were, as usual, distinctly visible on the forehead, and at the root of the nose. There were hard leathery portions of excoriated cutis, and a precisely similar patch upon the occipital protuberance [on the Continent, forceps are often applied so as to compress the child's head antero-posteriorly]. There was an extravasation of blood beneath the occipital aponeurosis. The vessels of the *pia mater* much congested, and the whole of the *basis cranii* had a layer of dark treacley blood spread over it, which is certainly a rare appearance. The right lung was of a bright brown colour, with reddish patches on it; the left lung was of one uniform dark brown. On incising the right lung, a faint sound of crepitation was heard, and a little bloody froth escaped; there was nothing of the kind seen or heard on cutting into the left one. The right lung floated perfectly, all but a few pieces which sank, and compression under water caused the usual pearly vesicles to ascend; the left lung sank completely. It was therefore evident that the right lung alone had commenced to respire."

Case IV. *Partial Respiration. Early Apoplexy.* [Casper, No. CCCLV.]

"A mature female child (with an osseous nucleus of 2 lines) was found one evening in spring lying dead upon the floor of a house. Three days subsequently it was placed upon our dissecting table, already greyish-green. The diaphragm was placed between the fourth and fifth ribs. Gaseous bullæ were scattered through the thymus. The lungs were retracted. The left was of a uniform brown colour, the right of a bright rosy-red, with a few bluish marblings. When the yet unseparated heart and lungs were laid upon the surface of the water, they sank but slowly. From this it was to be expected that individual portions of the lungs would float when they came to be separated. The weight of the right lung was 490 grains, the left 390 grains. When separated, the right lung floated, but when depressed beneath the surface it rose unusually slowly; the left lung sank at once to the bottom. When further divided into lobes, only the upper lobe of the right lung floated, while the others slowly sank. The two lobes of the left lung sank slowly. Finally, when cut into little pieces, only about a quarter of the right lung was found to be buoyant, and only three pieces of the left lung. No other organ floated. The lungs were not in the smallest degree putrid, and the right lung crepitated, and gave vent to a small quantity of bloody froth when cut into, the left one did neither. Evidently the child had made a few attempts to breathe; a small amount of inspired air had as usual got into the right lung, while a still smaller quantity had also got into the left one, and an apoplectic attack, the traces of which were distinctly visible, had ended its life immediately after its birth."

Case V. *Artificial Respiration. Difficulty of Diagnosis from Complications.* [Casper, CCCXLIII.]

"This was an extremely intricate case. An illegitimate female child was born in the eighth month (without any osseous nucleus in the femur). According to its mother's statement, which seemed on this point a little hazy, it had never cried. Shortly afterwards a (very little known) physician was called in, he found the child apparently lifeless, and holding its nose, attempted to *inflate its lungs* by blowing with his mouth directly into the child's. The dissection proved that this air had not got into the stomach. The diaphragm was placed between the fourth and fifth ribs. The liver and vena cava contained much treacley blood. The right lung distended the thoracic cavity, the left one was retracted. Both lungs were of a decided bright brownish red, mottled here and there; to this the middle lobe of the right lung presented a remarkable contrast from its bright cinnabar-red colour, in which there was no mottling. Both lungs crepitated under the knife, and emitted bloody froth very copiously. Both lungs were perfectly buoyant. The trachea was empty and perfectly normal. Within the cranium there was not only very well marked hyperæmia, but even small isolated patches of extravasation upon the base of the brain. What ought to be deduced from these appearances and the known facts of the case? The remarkable contrast presented to the rest of the lung by the unmottled cinnabar red of the middle lobe of the right lung, a colour which is acquired always, and without exception by lungs artificially inflated, evidently pointed to an attempt of this nature, which had so far been successful. While the light brown colour of the rest of the lungs, the mottlings, which, though not numerous, were still present; the perfect buoyancy of the lungs, which, as well as the entire body, were perfectly fresh, even to their smallest portions into which air artificially blown in could not have penetrated, without of necessity altering the colour of the lungs; for the same reason the crepitation emitted by the air on escaping; and, finally and specially, the large amount of blood contained in the lungs, which never could have got there by mere insufflation, all decided me [says Casper] on coming to the conclusion that the child had been alive during and subsequent to its birth (and had died from apoplexy, from a cause not revealed by the dissection); and in giving this opinion I did not exclude the possibility that air might have been artificially introduced into the lungs of the child after its death."

CASE VI. *Defective Ossification in the Left Parietal Bone.* [Casper's CCCLXX.]

"According to the statement of the midwife who was called in immediately after the delivery of the mother, a maid servant, who had secretly given birth to this child, it was then just in the act of drawing its last breath. The child, a boy, was perfectly mature [7 lbs., 20 inches, cranial diameters 3 × $4\frac{1}{4}$ × 5 inches, etc.] The lungs were of a cinnabar-red, mottled with blue, frothed and crepitated on being incised, and floated perfectly. In the middle of the left parietal bone there were two roundish openings close to one another, each three lines in diameter, and with serrated edges; the bone surrounding these openings was not in this case remarkably translucent. It was particularly interesting to find that a narrow spicula of bone ran right across one of these openings, thus at once completely removing any possible doubt as to the nature of its origin in defective ossification. The child had died from hyperæmia. After we had explained the nature of the apparent injury to the bone, the case was not further followed judicially, as the [German] law takes no notice of the mere concealment of an illegitimate pregnancy or birth," [whilst the English law does]. Casper and others give numerous instances of defective ossification: *see* his cases 369, 371, 372, 373, 374, &c., and Tardieu, *loc. cit.* As regards the possibility of mistake in reference to the mark of the funis round the neck, Casper states that "if we examine a number of fat and fresh bodies of children, especially in winter, we shall readily perceive it to be a possible error to mistake the *folds of the skin produced by the movements of the head, which remain strongly marked in the solidified fat,* and are very prominent, particularly in short necks, for the mark of a cord, unless we correct our erroneous impression by a proper consideration of the various criteria belonging to a true mark of strangulation, which will speedily teach us the truth."

Case VII. *Child taken out of a Night-chair. Death by Fall at Birth. Body made away with for economical reasons.* [Casper's CCCLXXXII.]

"The body of a mature new-born boy was found in a night-chair, with a placenta weighing 11 ozs., the child weighed 6½ lbs., and was 18 inches in length, but the diameters of the head and shoulders were small [3 × 4 × 4½ inches for the head, 4¼ for the shoulders]. The portion of the funis attached to the child was 14 inches long, torn across, with ragged edges, and tied. Beneath the pericranium, on the left parietal bone, there were a few isolated ecchymoses; no other trace of violence was to be found, either internally or externally. The body was perfectly fresh. Death had been caused by cerebral hyperæmia, not by suffocation. Respiratory life was indubitable. The placenta being found along with the child, the torn funis, the small diameters of the head and shoulders, and the secret delivery, were all in favour of the supposition of a precipitate birth; and the ecchymoses on the parietal bone made it also probable that the child had fallen on its head at its birth. A fall could not, however, have had effect if the birth had taken place upon the night-chair, and the child had fallen upon the soft semi-fluid (in May) mass of excrement; and in this case also, death would have been caused by suffocation, and not by cerebral hyperæmia. Accordingly, it would be supposed that this viable and live-born child had died soon after its birth from cerebral apoplexy, produced by falling upon some hard floor at its birth, and that after its death it had been flung into the night-chair to save the expense of burial, and more completely to conceal its birth."

Case VIII. *Injury of Carotid Artery and Spinal Cord of a New-born Child.* [Casper's 385th Case].

"An unmarried maidservant, pregnant for the second time, brought forth her child secretly in a cellar, during the night, and first killed it by repeated stabs with a table-knife, and subsequently inflicted many external injuries on it whilst dying, with a spade with which she buried it in the sand. The right carotid was punctured within the thorax by one stab, another completely severed the spine and spinal cord between the fifth and sixth cervical vertebræ. The medico-legal decision of the case was consequently easy. On the other hand, the following circumstance shows how important it is to proceed with the utmost carefulness in making a legal *post-mortem.* The accused stated, that after the child was born, and while it was still connected with her by means of the funis, she went into the adjoining room to fetch a table-knife with which to cut the umbilical cord; and that she then, *for the first time,* with the knife in her hand, and overwhelmed with fear and terror, was suddenly seized with the idea of killing her child, which she carried out. This view reduced her crime in the eyes of the criminal jurist to a mere act of homicide. Of course, at the dissection of the body, when no one could guess the subsequent confession, the condition of the edges of the remains of the umbilical cord had been carefully examined, and we had ascertained indubitably from the irregular, serrated, and denticulated edges, that the umbilical cord had not been severed by a sharp instrument, but had been torn across. The instrument employed by the murderess, and subsequently recognised as such by her, was *a very sharp knife*, she herself having sharpened it but the day before, along with the other knives of the house, therefore we were forced to maintain our original supposition in spite of this statement of the accused. Her crime thus regarded was 'murder,' for it was indubitable that she had not fetched the knife to divide the umbilical cord, but to kill the child after the cord had been severed, involving premeditation in the eyes of the judge. As the state of the mind of the accused at the time was not quite free from doubt, she was only condemned to the unusual punishment of many years' imprisonment."

Casper, in commenting on this case, very justly adds that a *blunt knife*, when used to divide the cord, may give it the appearance of having been torn, or half-sawn and half-torn. He also suggests softening the end of the cord in cold or warm water, when it has mummified, in order better to examine its edges. The child's constitution, and the state of the cord are also properly stated to modify the amount of hæmorrhage. Hohl remarking, very correctly, that thick gelatinous cords bleed more freely than thin and small ones.

CASE IX. *Birth into Excrement. Death from Suffocation. Sinking of the Lungs. Intentional Infanticide.* [This is Casper's 395th case, *loc. cit.*, p. 164.]

"This case was the most instructive of all those many similar ones which constantly come before us in regard to the value of the docimasia pulmonaris, and deserves to be detailed at length. This unmarried *primipara* had the usual story to tell; she was not expecting her confinement, and feeling a desire to go to stool, had been suddenly delivered of her child, whereupon she had become senseless, etc. The police report, however, supposed that she had flung the child into the privy *after* its birth, since the umbilical cord was cut, and the placenta wanting; the man who had the charge of emptying the cesspool at night having found the child in doing this, but not the placenta. The child was a mature girl (20¼ inches long, 7 lbs. weight, &c.), with the usual cranium and shoulder diameters (3 × 4¼ × 5; and 4¾ inches); in the mouth, fauces, and nostrils, was a considerable quantity of human ordure. The diaphragm stood between the fifth and sixth ribs, the stomach was *quite filled* with fluid human fæces. The vena cava was tolerably well filled with dark and not unusually fluid blood. Nothing else was found in the abdomen of any importance. The thymus gland was very large, and almost entirely covered the pericardium. With the heart, the lungs sank at once in the water; without the heart, they sank more slowly. Their colour was precisely that of the spleen, the middle lobe of the right lung, however, exhibited a few lentil-sized brighter patches; the edges of both lungs were also somewhat brighter in colour. Petechial ecchymoses were scattered over several parts of the lungs. Each lung, as well as each lobe, sank in water, but the middle lobe of the right lung very slowly. No portion, however, of the lung, even when cut into many pieces, showed itself buoyant. On making these incisions no crepitation was heard, yet, in isolated spots of both lungs, a very little bloody froth could be squeezed out; and from such spots, when squeezed under water, fine air bubbles ascended. The lungs themselves contained much blood. The mucous membrane of the trachea was of a bright rosy red, and was seen, with the aid of a magnifying glass, to be minutely injected. The œsophagus was empty. In each side of the heart there was about one dram of dark fluid blood. The bones of the cranium were uninjured; the veins of the *pia mater* were very full, those of *plexus choroidalis* unusually so, as were also those of the cerebellum and the sinuses. "In the written opinion which we gave [says Casper], we first proved the maturity of child and its viability. It had, however, lived and breathed, though only for an uncommonly short time, for . . . . . the docinasia pulmonaris has still afforded proof that the lungs contained *some air*, though only in trifling quantity, and consequently the result of but one, two, or three inspirations, since there is no other probable source for the air in this case. This proof consists in the position of the diaphragm, the brighter patches in the lungs, the bloody froth, and the fine air bubbles which ascended from the cut portions of the lung when squeezed under water. This case, therefore, like many similar ones, proves the great *delicacy and excellence of the docimasia pulmonaris*, which has here detected a respiratory life, that has ended almost as soon as begun." He then (without attaching undue importance to the position of the tongue between the teeth) ascribes the death to suffocation. "The child must thus have fallen into the fluid fæces alive, and must of course, have been drowned therein, and death from drowning is, in a large proportion of cases, death from suffocation." In reply to the inquiry, if the death of the child were intentional, Casper shows that the appearances all agreed with the woman's statement, that it was accidental; and though the placenta was not found, it appeared that the man who found the child did not know anything about the after-birth, and never looked for it. Other similar cases are to be found in Casper, who is, next to Tardieu, the best authority we have on these subjects. If we were to criticise him at all, it is for being sometimes a little too positive in regard to cases where putrefaction was advanced.

CASE X. *Infanticide by Suffocation.* [Tardieu's No. 1.]

The accused, Marie-Anastasie P., was aged 27 years, and single. She quitted her place of service at Arzillières early in March, 1854, in an advanced state of pregnancy, which she concealed, and denied to all who asked questions. She went to Paris and took service there. Her new mistress suspected her condition, but did not charge her with it. But on the girl keeping her bed "for a cold" on the 24th March, her mistress, after many denials on the girl's part, at last got a confession that she "believed" she was pregnant, but only admitting six, or at the most eight, months' gestation to be possible. Early next morning her master asked her how she was, and the girl said she was "no better." At a quarter to eight the same morning, her mistress on entering the room was informed that she had had colic, then that it was a miscarriage. Next the servant said, that at six o'clock, she had gone to the close-stool, and the infant was born and tumbled into the pan, that it had only cried once, sighed once or twice, and then died. Then she said it had fallen on the ground and not into the pan. The master and mistress sent for M. Lebreton, their own medical man, who found the child still warm, but dead. There was no trace of external violence, but it was wrapped in a petticoat, which closely covered it all over. He considered the child viable, but could not determine whether negligence or crime was the cause of the suffocation. M. Tardieu was consulted, and states that the infant was a girl, strong and vigorous looking, 20 inches long, and weighing 6 lbs., the osseous nucleus well developed. The funis was torn and not tied. There was no putrefaction. The head, neck, and upper part of the chest were of a deep violet colour, presenting no signs of excoriation. On the surface of the scalp there were a great many little extravasations of blood, distinct from the caput succedaneum. No fractures. The lungs floated, though not buoyantly; they were gorged with blood, and presented a dull red colour on the surface, with a number of punctiform ecchymoses on the under surface of the pleura, which were blackish in colour, and gave the lungs an appearance of granite. The larynx and trachea contained sanguineous froth. The surface of the pericardium covering the heart was also ecchymosed. The heart contained only fluid blood. The abdominal viscera were normal, but the stomach was distended by a large quantity of bloody mucus. M. Tardieu concluded: 1. That the infant was mature, vigorous and viable. 2. It had lived and breathed. 3. The death was due to suffocation, the air having been hindered forcibly from entering the air-passages. 4. There was no reason to attribute death to any accidents of parturition, or to any feebleness on the part of the infant.

In Tardieu's second case, also due to suffocation, there was some dispute on the meaning of the facts. The accused stated that the presentation was podalic, and that the child was cold before it was born. This last statement was inconsistent with the time of year, the colour, &c., of the skin, and with the fact that the docimasia pulmonum had shown that respiration was fully established. There was nothing to confirm the accused's statements as to the presentation.

CASE XI. [Tardieu's 6th case.]

In this case the vigorous and mature male child of a single woman was found in a tub of bran. This infant weighed 6 lbs., the osseous nucleus of the femur was well-marked. The cord, not tied, was broken at fourteen inches from the navel. All the body was covered with a fine dust (of bran). The nose and mouth were filled with the same. In the lungs, which were mottled and very large, there was much emphysema, and subpleural ecchymoses. They floated, both entire and in fragments, but not buoyantly. The trachea contained bloody froth, and some bran-dust. The heart was empty. The stomach contained bloody mucus, other abdominal organs normal. Conclusions: 1. The infant was mature, viable, and robust. 2. It had lived and breathed. 3. Death was the result of suffocation. 4. This was not due to the birth, but to the bran.

CASE XII. *Infanticide by Suffocation. Infant shut up in a Box.* [Tardieu's 7th case.]

This was a female infant, mature, and well formed. The cord was cut and not tied. The post-mortem symptoms were those of suffocation. The child had clearly lived and breathed well. Death was, however, not due to the box, for the lower lip was turned inside out, and flattened, its mucous membrane resembled parchment, and bore the marks of a woven fabric, some portions of which adhered to it. The tongue also had some fluff on it. It had clearly been suffocated by a linen cloth applied to the mouth.

Case XIII. [Tardieu's 10th case.]

Parts of the child of a single woman were found in a small tub, which contained six pieces, the head and one foot were missing. The trunk had not been opened. It was much putrefied. The cord was broken off at about 2½ inches from the navel. Osseous nucleus large. The lungs marked with sub-pleural ecchymoses. The mutilation was done by some blunt instrument. The sexual organs, one foot, and the head were wanting. The condition of the lungs showed death from suffocation. A head was discovered seventeen days after, which corresponded to the dimensions of the body. There were marks of compression at the sides of the nose and inside the upper lip. These confirmed the conclusion that the infant had been violently suffocated.

Case XIV. *Infanticide from Suffocation by a Paper Plug in the Mouth.* [Tardieu's 11th case.]

"On June 3rd, 1855, at the Paris Morgue, an infant was examined, who had been found in a public privy [fosse d'aisance], and whose mouth was stuffed up with a piece of paper. It was of about 8½ months, small, and weighed rather less than 4½ lbs. It was not much putrefied [five or six days perhaps in the privy]. Cord entire, attached to placenta. No signs of violence. There were post-mortem stains on the knees and fronts of the legs. Mouth disfigured. The lungs pale red, very large, and had clearly breathed. There were numerous sub-pleural ecchymoses. Heart full of fluid blood. Decomposed blood in the stomach. Death clearly due to suffocation by the paper. Thrown into the privy after death."

Case XV. *Infanticide by Fracture of Skull.* [Tardieu's 20th case.]

Examination of the Body of the New-born Child of a Single Woman called Chardon.

The child was a male, 16½ inches long, and 3⅓ lbs. in weight. The cord had been broken at 6½ inches from the navel. No osseous nucleus in lower end of either femur. At the neck and on the knee there were severe bruises, and the apophyses of the bones were broken off. The scalp was distended by a thick layer of fluid blood, particularly on the right side. Here the whole right parietal bone was broken into many fragments, the dura mater torn, and the brain substance escaping. The lungs rosy red, not very large, floated and contained air all over. Stomach empty. Abdominal viscera normal. Conclusions: (1) The child had reached eight months of intra-uterine life, it was well-formed, viable, and newly-born. (2) It had lived and breathed. (3) It died from the fracture of the skull, caused either by a very violent blow, or by a fall from a great height. (4) This fracture was not accidental, any more than the injuries to the limbs. It did not happen in the birth.

CASE XVI. *Infanticide by Crushing of the Skull. The infant had lived but not breathed.* [Tardieu's 21st case.]

M. Tardieu was asked to give an opinion on the facts elicited by Dr. Tercinier's careful examination of a female and her infant from Cognac [Charente-Inférieure]. As regards the woman it was certain that she had been recently delivered. The infant, dug out of the ground, weighed nearly 5½ lbs., and was full 20 inches long. There was, however, no distinct osseous nucleus in either femur—only well marked vascularity. In other respects the body was well developed. It was much decomposed. The lungs floated at first, but on the bubbles of gas being pressed out, they sank completely, and were of a dull red. The head appeared flattened, and as it were crushed, the bones of the skull were broken in many parts, and into many fragments. One of these had perforated the hairy scalp. These fractures extended from one side of the head to the other, and included both parietal and the two temporal bones, and were accompanied with a very circumscribed effusion of blood, *coagulated at the very spot where it had escaped.* There was also sanguineous infiltration of the tissues, resisting repeated washings and rubbings, and extending all over the hairy scalp covering the fractures. MM. Tercinier and Tardieu concluded that the infant was not mature, but was very nearly so; that it had not breathed, but had lived [chiefly inferred from the coagulation of the blood]; that it was probably born alive, but killed at once, before it had time to breathe; and that the death was due to the crushing of the skull, this being due to criminal violence.

CASE XVII. *Death by Suffocation.* [Tardieu's 28th case.]

M. Tardieu was asked to examine a woman in prison, suspected of infanticide. She was tall and strong, and said that three days before she had been suddenly delivered after only three or four sharp pains, a fortnight before term. She was not in bed. She said the child came out and went in again, and she was obliged to seize it by the neck. She said it *scarcely* showed any signs of life, and had not uttered a single cry. She had thrown the after-birth into the privy—it came with the child. The sexual organs were the seat of a sanguineous flow, having the characteristic odour of the lochia. Her chemise was much soiled with it. The vulvar aperture was much dilated. The abdominal walls were relaxed and thrown into folds [*lit.* pleated]. The uterus was still large and could be felt above the pubis. The breasts were very large, hard, and gorged. The pulse quick, face flushed. It was therefore concluded that she had been delivered, and that within four days.

Examination of the infant. A girl, weighed almost 7½ lbs, measured 20¼ inches, [11 inches to the navel]. Head measured 4½ × 3 inches. The cord torn off at ½ an inch from the navel. Nose flattened. Marks of pressure each side the nose. Each side of the windpipe there were bruises like nails (of the fingers) in shape, three on the left, one on the right, pressed inwards. There was subjacent infiltration. Lungs large, floated, marked with ecchymotic spots. Heart contains dark coagulated blood, stomach empty, free from saliva. The intestines showed intussusception. Conclusions: (1) The child was mature, born at term, well formed, and viable. (2) It was born alive, air completely filled the lungs, and in all human probability it must have cried. (3) It was killed by pressure on the mouth and nose, and by the pressure of the fingers on the throat (windpipe). The lungs showed that it had probably struggled. (4) It was suffocated soon after birth, and had swallowed nothing. (5) These injuries were not inflicted in the attempt at self-delivery—their seat shows this.

CASE XVIII. *Were these Injuries done by the Police?* [Tardieu's 37th case.]

M. Tardieu was consulted by letter on a very singular case, in which the infant of a domestic servant was found in the pipe of a closet, the pan of which had the peculiarity of only being open when the user was seated in the closet. ["La cuvette de ces lieux est à bascule, c'est-à-dire ne s'ouvre qu'au moment où l'on est assis sur le siége."] The pipe was large enough to admit the infant, but the body stuck part way down the pipe, and the police, by order of a magistrate, tried to shove it down, and succeeded by means of a heavy leaden weight in doing so. The curious question arose if the marks of violence on the infant's head and face were due to the violence thus used, or were there before; also whether the child had accidentally fallen into the pipe in being born. To these questions M. Tardieu was able to respond:—(1) That the cord was too strong to allow of the child thus falling through the pan into the pipe. It had been violently torn off at little more than 3 inches from the navel. (2) The injuries to the head were too serious and too general to have been caused by the police. The child was doubtless dead before, as there were no marks of bruising. (3) Death was doubtless due to criminal violence.*

CASE XIX. *An infant thrown alive into a privy.* [Tardieu's 49th case.]

Autopsy, January 18, 1850. Length $20\frac{1}{2}$ inches, of which 12 inches from head to navel. Weight, 5 lbs. 10 ozs.; diameters of head, $4\frac{1}{3}$ inches fronto-occipital, $3\frac{7}{10}$ bi-parietal. Cord torn off, not cut, not tied. No putrefaction, colour normal, odour fæcal. The examination led to the following conclusions—(1) This male infant was mature, born alive, and viable. (2) It lived and breathed. (3) Death resulted from immersion in the privy. (4) The flattening of the head and the ecchymoses on its most prominent parts show that pressure was exerted to force it into the privy, and that it did not get there by accident. (5) The state of the lungs, and the quantity of fæces in the stomach show that the child was thrown alive into the privy. In Tardieu's next case (No. 50), the infant was thrown alive into a drain, but was rescued living, and made a good recovery.

CASE XX. *An infant killed by wounds inflicted by a pair of scissors.* [Tardieu's 54th case.]

Autopsy made at the Morgue on the 16th January, 1859, on the child of a single woman called Carlet, born at the seventh month. Weight

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* The *cephalotribe*, and other obstetric instruments, cause crushing of the head in the infants to whom they are used. Those who have seen such would easily recognize the appearance. But in such a case, there would probably be deformity of the

$2\frac{3}{4}$ lbs. It was covered with blood. The cord had been cut by a doctor who arrived just as the child was dead. At the top of the head was a wound in the shape of an M, with its edges somewhat bruised, certainly made with scissors, certainly not caused by a fall. Blood infiltrated and coagulated beneath and around the wound. Bones and brains uninjured. Lungs in the fœtal state, not expanded. The heart contained blood. The infant had been born alive, but respiration was never established. It was alive, but its life was intra-uterine when it was wounded with the scissors, and as the child was premature, this wound was quite severe enough to cause death. The woman had milk-fever, sanguineous lochia. Uterus still large, and other traces of a very recent delivery.

CASE XXI. *Infanticide. Infant boiled in lye, then cut into pieces, and put into a barrel of vinegar. Medico-legal questions. Examination of lungs.* [Tardieu's 55th case.]

On the 30th August, 1865, at Mésanger, about 4·30 a.m., Jeanne Lévêque went to the room of her servant, a girl called Lefeuvre, and asked her to make her a cup of black coffee—when the servant returned she saw her mistress stooping in one corner of a cabinet opening into the room. At 8 p.m. she was found lying in the servant's bed. There was blood on the floor, and on her sabots. She said she had toothache and pain at the heart, that she had spat blood and that her nose had bled. She had for some time been supposed to be pregnant through her brother-in-law, and the servant did not doubt that her mistress had been delivered, though the latter still denied it vigorously. But when she was medically examined, there could be no doubt of her condition. She then *recollected* that on the 30th of August she had given birth to a male child. She pretended, however, that it had never cried. She had covered it up in a counterpane folded up into four, and carried the corpse into an empty bed in another room. Her sister came to see her at 11 p.m. She told her sister she had vomited blood, and still denied the birth. The domestic buried the child at 10 p.m. that night, in the high road four miles off. At 4 a.m. she dug it up again, and threw it into a caldron of boiling lye. After some time she pulled it to pieces with her hands. She divided it into small morsels, and then put it into a barrel of vinegar, through the bung hole, which was less than 2 inches in diameter.

Notwithstanding all this boiling, &c., it was possible to recognize parts of nearly all the organs. Thus, bones of the head and face, part of the chest, the pelvis, tongue, liver, intestine, heart, and lung, were all recognizable. They clearly belonged to a mature child, well formed, and healthy. The examination of the lungs made it probable that the child had breathed for a few seconds. These remains were afterwards submitted to Dr. Thoinnet who was able to recognize all the parts named, and to establish that they had been forcibly torn apart. The flesh was

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mother's pelvis—for infant life is too easily destroyed to render it probable that either a midwife or male accoucher would take the trouble to crush the head of an infant when there was no disproportion between the head and the pelvis. The possibility, however, should not be forgotten. [Guy's Hospital Museum and that of the Obstetrical Society contain some casts of such heads. See also a paper of Dr. Bruxton Hicks in the "Obstetrical Society's Transactions."]

sodden, and loose from the bones, the skin was gelatinized ; the crystalline lens was a white and solid bead like a fish's eye when boiled. The spine had been divided by some cutting instrument. The heart had been cut in two—to one of these pieces one lobe of the right lung was attached. The lung tissue was reddish, it crepitated under the fingers, but no gas escaped. Put into water, it sank slowly, and remained suspended, or resting on one of its corners at the bottom of the vessel. Other fragments of darker colour sank at once. Before reporting, Dr. Thoinnet tried a comparative experiment on the lungs of a young calf, which he boiled in lye till thoroughly cooked, till they had the same colour as those of the child. Though the animal had lived some days, the lungs, after the combined action of the boiling lye and the vinegar, showed the same results as those of the child of Jeanne Lévêque.

Case XXII. *An infant burnt. Examination of the remains.* [Tardieu's 56th case.] (By Messrs. Ch. Robin and A. Tardieu.)

This report is of great interest, but very lengthy. The careful examination of the cinders and other remains proved that one packet sent to the reporters was the bones of a young pig—another packet contained a number of fœtal bones, more or less perfect, from an infant at term. The presence of phosphorus and calcium was determined in the ashes—also animal fat. In another packet there were only portions of earth, mould, and other mineral and vegetable matters. A handkerchief supposed to be soiled with blood, was proved to be free from this.

Tardieu's 57th and 58th cases are also those of remains of infants attempted to be destroyed by fire. The latter is known as the "*Affaire Lemoine.*" The medical witnesses found great difficulty in identifying any individual bones. A portion of one orbit, some remains of vertebræ, and part of the right frontal bone were most evident in this case. These memoirs should be consulted in the original by all who have cases of such difficulty and delicacy to determine.

It may, however, be stated in general terms, that no matter what the violence to which an infant has been subjected, in order to destroy it, there will usually be found some means of determining its age, and whether it were born alive or not. In those rare cases in which fire has been used to conceal the crime, some portions are likely to remain unconsumed, and in any case chemical and microscopic examination, combined, will be almost sure to throw some light on these dark passages of human history and crime.

Legitimacy and Superfœtation. Disputed Paternity.

The genetic portion of our subject would be incomplete without some reference to two subjects, which are often discussed in our courts of law. The House of Lords is generally compelled to discuss the question of legitimacy when a peerage is claimed, and the question is often raised in other courts when the succession to estates is disputed. In a medico-legal sense *paternity* and *legitimacy* are almost identical. Sometimes, however, the fact of a woman's having had more husbands than one renders the question of paternity less simple. *Superfœtation* is a sort of corollary to the curious question of legitimacy. You have already had the facts of some celebrated cases laid before you in the section on the duration of pregnancy [*see* pages 701, etc., for accounts of the *Jardine*, *Elder* of Whithorn, and *Gardner Peerage* cases]. Speaking broadly, the law regards all children born in wedlock as legitimate, unless good reasons can be shown to the contrary. The following are common cases of disputed paternity.

I. A child [or children] may be born after the husband's death. [Such children are styled posthumous, from the Latin *posthumus*], or,

II. A child may be born a little before the death of the husband, his health having failed for some months previous, either from disease or accident. In such cases you will probably be asked—

(*a*) Was the supposed father capable of begetting a child within the period named?
(*b*) Does the child's size, weight, and development agree with the mother's statement as to the period of gestation? or, with the facts obtained in evidence from others?
(*c*) What is the normal duration of pregnancy? Can this be prolonged, and if so, how much beyond the usual period?

III. A woman has a child in the absence of her husband, or very hortly after her marriage. In the former case you will probably be sked—

(*d*) Does the period of gestation, as inferred from the size and development of the child, agree with the facts as to the possibility of marital access?

In the latter case the question will probably be—

(*e*) What is the earliest period at which a child is *viable?* or capable of living if due care be taken of it?

IV. After giving birth to one [probably immature] child, the woman, fter a short interval, gives birth to a second [mature] child, [or the acts as to maturity may be *vice versâ*], and you will be asked—

(*f*) Is this an instance of *superfœtation?* or,
(*g*) Were both children the issue of a single *coitus?*

V. A woman marries again immediately after the death of her husand, or after divorce. A child being soon after born to her, you are sked—

(*h*) Is this the child of the dead (or divorced) husband, or of the living one?

VI. Sometimes, during the lifetime of a husband, a woman aided by iends or accomplices, will pretend an accouchement, and palm off the hild of another upon her husband or upon others. The questions arising ut of this state of affairs may be complex. Usually speaking, there ill be no enquiry made until some of the witnesses who could throw ght upon the matter are either dead or have left the country. In eneral terms, it may be said that the following questions are probable—

(*i*) Has this woman ever had a child? or
(*k*) Were the facts detailed by the witnesses consistent, one with another? or were there suspicious circumstances in the case?

(*l*) Was the woman's age consistent with child-bearing? or
(*m*) Was it probable so old or feeble a man would have a child?
(*n*) Does the child resemble either father or mother, or has it any peculiar marks by which it may be identified?

Very often large landed estates, titles, and vast sums of money depend upon the answers given to such questions. A treatise of great length might easily be written on this subject. But if we come to analyse the questions just propounded, it will be found that we can refer them all to the following categories :—

A. What are the limits or range as to the age of fruitfulness in both sexes?

B. What is the normal duration of pregnancy? Is this ever exceeded? if so, how far?

C. When is a child *viable?* or, in other words, how far may we *anticipate* the average date of delivery, without the child necessarily perishing.

D. Is or was [so and so] impotent or sterile, and thus incapable of fruitful coitus? If so, why? In other words, what diseases, accidents, or conditions cause sterility or impotence?

E. Was the child whose legitimacy is questioned fully developed? or did its size, weight, and development, correspond to earlier periods of gestation?

F. Can a woman, already pregnant, conceive again? Or are cases resembling this to be explained otherwise?

G. Do children necessarily resemble their parents?

We shall briefly discuss these questions in their order, and then append a very few illustrative cases.

A. What are the limits, as regards age, of fruitfulness in both sexes?

As regards the power of procreation, the majority, both of our judges and of eminent medical authorities, are not disposed to lay down any precise limit as to old age in the *male.* Some remarks on this subject will be found at pp. 682 and 683. Bodily vigour is to be regarded far more than mere age. In the *female,* however, a limit to fruitfulness is generally set by the cessation of the catamenia. This usually occurs either before or about the age of forty-five years. It is by no means safe to pronounce a woman incapable of bearing children merely on account of an aged appearance. Pliny records that Cornelia, of the family of the Scipios, at the age of sixty, bore a son called Volusius Saturninus. The late Dr. Ramsbotham met with a case of pregnancy (known also to the authors) in a woman aged fifty-eight—her age being proved by the parish register—whilst her appearance was that of a woman at least ten years older. She was not only pregnant, but was duly delivered at term of a vigorous and well-formed child. Haller [quoted by Briand, "Manuel complet de Méd. légale, p. 137,] records two cases in which women at sixty-three and seventy bore children. Dr. Davies, of Hertford, ("Medical Gazette," vol. xxxix., p. 950), writes of a woman who menstruated up to the time of her last pregnancy, and this child was born when she was fifty-five years of age. Dr. Taylor quotes the following table from Nevermann.

Out of 1,000 cases (in 10,000 births), he found that 436 children were born by females at the ages respectively

Of 41 years,	101	Of 48 years,	8
„ 42 „	113	„ 49 „	6
„ 43 „	70	„ 50 „	9
„ 44 „	58	„ 52 „	1
„ 45 „	43	„ 53 „	1
„ 46 „	12	„ 54 „	1*
„ 47 „	13		

The Registrar-General for Scotland (February, 1862), reports two women as becoming mothers at fifty-one years of age, four at fifty-two years, and one woman was registered as in the fifty-seventh year of her age when she gave birth to a child. On the ground of Vice-Chancellor Kindersley's decision in *Forty* v. *Forty*, (Feb. 1853), Dr. Taylor states that a woman who has passed the age of fifty-three is presumed in law to be past the age for child-bearing ("Medical Times and Gazette," 1871, vol. ii., p. 114).

On the other hand, there are numerous cases on record of very young mothers—Sir Eardley Wilmot gave Dr. Taylor particulars of a case [*Reg.* v. *Chattaway*, Coventry Summer Assizes, 1848], in which a man aged forty-five was convicted of rape on a girl aged eleven years and eight months. When 12½ years old she was in the last month of her pregnancy. Beck mentions a case in which a girl menstruated at one year, and became a mother at a *little over ten years* of age [*loc. cit.*, p. 368]. "On the 20th April, 1834, this female, aged ten years and thirteen days, was delivered of a female child weighing 7¾ lbs. This occurred in Hickman County, Kentucky, and is related by Dr. D. Rowlett, of Waisborough, in that State. ["Transylvania Journal," vol. vii., p. 447.] Another became a mother at twelve years and eight months, ["Amer. Journal of Medical Science," Oct. 1846, p. 547]. Rüttel gives a case of a girl of fourteen pregnant by a boy of the same age. He also quotes three other cases where one girl of the age of nine, and two of the age of thirteen became pregnant. (Henke's "Zeitschrift der S. A.," 1844, p. 249). Dr. Wilson ("Edinburgh Medical Journal," Oct. 1861) mentions a girl of 13½ as giving birth to a full-grown child. She must therefore have become pregnant at 12¾. Mr. Roberton, of Manchester, mentions a factory girl who became pregnant in her eleventh year.† A girl under thirteen who became pregnant at 12¼ came before a magistrate at Wandsworth, September, 1871. [Other cases will be found in Dr. Norman Cheever's work on "Indian Medical Jurisprudence," and in Dr. Montgomery's "Signs and Symptoms of Pregnancy," p. 310, etc.] Dr. Goodeve says of Calcutta, "the earliest age at which I have *known* a Hindoo woman bear a child is ten years, but I have *heard* of one at nine."

The previous occurrence of menstruation is not essential to child-bearing; of this there are almost innumerable instances, so that La Motte says (Obs. xxiii.) "Qu'une femme peut porter du fruit, avant de leurs." Dr. Taylor quotes a case from Mr. Pearson of Staleybridge, to show that a woman may cease to menstruate, and yet be pregnant eighteen months after. The authors know of similar cases.

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* Dr. Montgomery's table for the Manchester Lying-in Hospital is very similar [*loc. cit.* p. 315.]

† "Essays and Notes, &c., on Midwifery," p. 29.

If it be difficult to strictly define the limits of child-bearing as to age, it is also not easy to say what limit as to *numbers* can be fixed. A nurse at the London Hospital, known to the authors, had twenty children in nineteen years, viz., eight single births, twins three times, triplets twice. Dr. Dyte attended a woman for the maternity charity of this hospital in her twenty-sixth labour [" Lond. Hosp. Reports," vol. i., p. 208]. The late Mr. Guthrie knew a lady who had twenty-eight living children in the first twelve years of her married life. Putting aside all the apocryphal cases, such as that of the lady who had 365 children at a birth ! [*] it may be remarked that five, and even six, children have been produced by human females at one birth [Dr. Rüttel's case—Henke's " Zeitschrift," 1844, p, 226]. See also other cases reported by Dr. Taylor (*loc. cit.*, p. 224, &c.). On a tombstone in Heyden churchyard, near Hull, there is said to be the following epitaph :—

> " Here lies the body of William Sturt, of Patrington, buried May 18, 1685, aged 97 years. He had children by his first wife 28, by his second 17 ; was father to 45 ; grandfather to 86 ; great-grandfather to 97 ; great-great-grandfather to 23 ; in all 251."

B. As regards the *normal duration* of *pregnancy* in the human female, we must refer you to page 698—702, merely reminding you here that 270—280 days, or 275 on an average, is the *usual* period. This is often *abbreviated*, the child being proportionally smaller, and less developed. On the other hand, it is very seldom exceeded, and although the analogy of the lower animals and experience combine to show that it has occasionally been protracted, *yet there is no reliable case on record* of more than 308 days. Even such a limit is very improbable, and cases which appear to rest on good authority are probably due to mistaken reckoning. Such a case as is recorded in the " British Medical Journal " for April 22nd, 1876, p. 505, bears with it its own refutation.[†] All longer periods must, in the present state of our knowledge, be considered as quite apocryphal.

C. In answer to, *When is a child viable ?* you will find information at pages 701 and 749. The practical outcome is, that although some few children, with extraordinary care and precautions, may survive if born between the fifth and sixth months, yet, generally speaking, a child is not viable until the seventh month of utero-gestation.

D. An answer to the question as to *impotence or sterility* should never be given hastily. The facts which form a basis for such replies will be found at pages 679 to 683. Impotency and sterility, on the part of either male or female, should never be assumed without very strong evidence. Very old men may be fathers, for spermatozoa in a lively state are often found in their semen. Even *paraplegia*, though it puts difficulties in the way of copulation does not always prevent insemination [Curling, "On the Testis," p. 371.] It is not necessary that a man should have both testicles, nor even the whole of one, since a very small quantity of the secreting structure or semen stored up in the vesiculæ seminales (which may be the case for a time, even after castration) will suffice for the generative act. *Lingering diseases* usually destroy sexual vigour and capacity. *Diabetes, locomotor ataxy, wasting paralysis*, and other forms of severe or chronic neurosis are generally accompanied with loss of sexual power. Phthisis has been popularly supposed to be an exception. The authors know of one case in which a patient suffering from phthisis of tubercular origin had connection on the very day of his death, and the wife was delivered of a child on the 280th day after. This fact does not rest simply on the statement of the wife. On the other hand, sexual capacity may be absent where there is every appearance of bodily vigour, although such cases are rare. One of our modern Nimrods, who was tall and athletic, was totally impotent. In forming our judgment in cases of disputed legitimacy we should not lay too much stress on exceptional cases. A very aged, bedridden, diseased, and helpless man, *may* be the father of a strong, stout, well-formed, and vigorous child, but it is not probable. Very large herniæ, prolapsus ani when severe, cystitis, and large or numerous stones in the bladder, dropsy when far advanced, gout, and arthritis deformans when very severe, and fractures of the pelvis, spine, and of some other bones, would all render sexual intercourse very difficult. On this delicate topic the authors would say (from facts which have come under their cognizance) that it is far better to state frankly that such and such conditions must render [*or* have rendered] sexual intercourse *very difficult* or *well-nigh* impossible, rather than to state absolutely that it is or was impossible.

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[*] A writer called Goftr (" Hegenetii Itinerarum," &c. 1630) says he saw a tablet in the church at Leusdon (Lausdunum) about 5 miles from the Hague, with an inscription to the following effect :—that in the year 1276, a certain illustrious countess, in the fortieth year of her age, brought forth at one birth, 365 infants ! all of whom were baptized by Guido, the suffragan, who called the males " John," and the females " Elizabeth." Ryan's " Midwifery," pp. 115, 116.

[†] Owing to the husband's misconduct, the wife was living separate. Although 298 days were supposed to have passed from the last coitus, yet the child only weighed five pounds—the umbilical cord was thin and weak, and looked shrunken. There was a good deal of hæmorrhage. The case is rather imperfectly recorded. We are not even told whether the child was born alive, although this was probably the case.

E. As to the *development of the child, and its maturity*, we have already given you details and references at pp. 644 and 779. The length, weight, condition of skin, and the measurements of the skull, shoulders, and long bones, with the dimensions of the osseous nucleus of the lower end of the femur and other bones, are the principal points on which you must found your judgment.*

F. The answer to the question whether a pregnant woman can conceive again, whilst one child is in utero, involves the question of *superfœtation*. Ancient medical writers almost all believed in the possibility of this. Beck quotes Brassarolus, to the effect that he had seen *epidemics* of superfœtation! Zacchias ("Consilia," No. 66) states that J. N. Sobrejus lost his life in a quarrel, leaving his wife *enceinte*. Eight months after his death she gave birth to a deformed child, which died in partu. The abdomen remained large. One month and a day after she gave birth to a perfect living child. Its legitimacy was suspected. Zacchias argued that there must have been two conceptions, on the ground of the long interval. He considered, however, that the *first* was the product of the superfœtation, and conceived a month after the other. This opinion established the legal rights of the mother, and preserved her character. Fodéré (vol. i., p. 484) says he is assured that a woman at Turin, in 1797, was successively delivered of three children, at intervals of fifteen days between each. The authors know of more than one case in which there was an interval of a week between well-formed, mature twins. Denman, in his "Midwifery," quotes a case from Lady Farquhar, in which a woman had a severe fright between the fifth and sixth months of pregnancy, after which her bulk was reduced. She went the full nine months; and on the 11th of February was delivered of a healthy child: she continued in pain, and on the 25th of that month there was born the head and parts of a child that had just the appearance of a miscarriage of four months. Dr. Beck refers also to a case by Mr. Warner in the "Philosophical Transactions," vol. lx., p. 453. Mr. Chapman, in the "Medico-Chirurgical Transactions," vol. ix., p. 194, narrates "A singular case of expulsion of a blighted fœtus and placenta at seven months, a living child still remaining to the full period of gestation." The placenta expelled at seven months was "the size they usually are between five and six months, to which was attached the membranes also, quite perfect, but of a dirty yellow colour, flattened, and closely embracing a small fœtus, not larger than they are generally seen between three and four months." Beck (Notes to pp. 144 and 145) gives many other references. Buffon speaks of a case of a woman at Charleston, South Carolina, who gave birth to twins, in 1714, one white, one black, very soon after one another. She confessed that immediately after her husband had left her bed, she was forcibly raped by a negro. [Fodéré, vol. i., p. 482.] Dr. Moseley ["On Tropical Diseases," &c., p. 111] tells of a negress who brought forth two children, one a negro, the other a mulatto. She said that a white man on the estate had had intercourse with her directly her black husband had quitted her. Cases of this kind appear to have been numerous in tropical and slave-holding countries; for Beck gives nearly half a page of references to such cases. Dr. Elliottson also mentions others ("Human Physiology," part iii., p. 781, &c.), and quotes Pliny ("Hist. Nat., vii. 9), as follows:—"Ubi paululum temporis inter duos conceptus intercessit, utrumque perficitur." The story of Hercules and Iphicles [sons of Alcmena, by Jove and Amphitryon] is familiar to all readers of the classics. The Rev. Dr. Walsh, in his notices of Brazil [vol. ii., p. 90] narrates circumstantially the case of a creole woman, who had three children at a birth, of three different colours, white, brown, and black, with all the features of the respective classes.

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* See also Anthropometrical Observations, by Dr. P. Boulton, "British Medical Journal," March 4, 1876, p. 280.

Dr. Maton ["Transact. London Coll. Phys.," vol. iv., p. 161] published the following:—"Mrs. T——, an Italian, married to an Englishman in Sicily, was delivered Nov. 12, 1807, of a healthy male child, which only survived its birth nine days. On Feb. 2, 1808, not quite three months after, she was delivered of another male infant, completely formed. He died of measles when three months old. It appears that both children were born perfect and mature. The husband himself communicated the circumstances."

The case communicated by Dr. Desgranges, of Lyons, to Fodéré [vol. i., p. 484-5-6], is one of the most curious. The wife of Raymond Villard married when twenty-two years of age. She became pregnant five years after, but had an abortion at the seventh month, on the 20th May, 1779. She conceived again within a month, and on the 20th January, 1780, eight months after her delivery, and seven months from her second conception, she brought forth a living child. This delivery was not accompanied with the usual symptoms, no milk appeared, the lochia were wanting, the abdomen remained large. A wet-nurse was got for the child, and two surgeons visited the mother; and being puzzled called in Dr. Desgranges, who declared she had a second child in the womb. This was doubted, but three weeks after her delivery she felt the motion of the fœtus, and on the 6th July, 1780 (five months and sixteen days after the first birth), she was again delivered of another living daughter. Milk now appeared, and she was able to suckle this infant. Dr. Desgranges adds, that it is not possible that this second child could have been conceived after the delivery of the first. "Car le mari ne lui avait renouvelé ses caresses que vingt jours après, ce qui n'aurait donné au second enfant que quatre mois vingt-sept jours." The narrative of this case was accompanied with a legal attestation of it under the oath of the mother; and on the 19th of January, 1782, both children were still living.

Dr. George Lindsay Bonnar, of Cupar, Fife [in his "Critical Inquiry regarding Superfœtation, with Cases," "Edinburgh Med. Journal," January, 1865], not satisfied with the common notion that a month or thirty days must elapse between delivery and a fresh conception, investigated the subject by referring to "Lodge's Peerage and Baronetage," in which he found at least nineteen recorded cases, in which the interval between one birth and another has been 309 days *or less.* There were ten cases of 309 to 300 days, two of 299 to 290, four of 289 to 280, one of 273, one of 252, one of 182, one of 173, and one of 127 days. Taking these cases and the facts relating to the state of the uterus, vagina, and lochia, Dr. Bonnar fixes on the *fourteenth day* after delivery as the earliest at which a fresh impregnation may take place.

Our space forbids us to multiply quotations, or to discuss this question at length. (1) Many of these cases may be explained by the fact that the *uterus*, like the vagina, and other organs, is sometimes found to be *double*, or *bipartite* in the human female. But one of M. Bigaud's cases, in which there was proved after death to be a single, normal uterus, gave birth to a *second mature* child four and a half months after the birth of the first. (2) Retention of one twin (from a single coitus) after the birth of the first will explain some cases. (3) An interval between insemination and fructification of the ovum (*see* note to page 705), will explain others. (4) Some instances may possibly be explained by pre-existing extra-uterine fœtation. (5) Want of accurate observation is probably the key to some cases, which *as reported* appear inexplicable.

After making all possible deduction for the reasons just stated, we still consider that there is a residuum of unexplained cases, and that without formally pronouncing in favour of the doctrine of superfœtation, we must admit that it is difficult to explain some of the recorded facts on any other supposition than that a second impregnation took place, whilst the uterus or womb contained one ovum or fœtus partially developed. One of Dr. Bonnar's cases (quoted by Dr. Taylor) is very remarkable. The Hon. Arthur Cole Hamilton, second son of the first Lord Mountflorence, married, in 1780, Letitia, daughter of Claudius Hamilton, and had a son born July 7, 1781, who lived to maturity, and a daughter, Letitia, born January 5, 1782, who lived and married Major Stafford. Between the two deliveries there was an interval of only 182 days. If we assume fourteen days before prolific intercourse, then the period for the second child is only 168 days or twenty-four weeks, or little over five and a half months.

G. *Although children often do resemble their parents*, and that most remarkably; the colour of the hair, eyes, and skin, polydactylism, transposition of viscera, hypospadias, and other peculiarities being transmitted, they need not necessarily be so. In other words, the absence of remarkable likeness, or of transmitted defects or other peculiarities, does not necessarily disprove paternity or legitimacy. The facts known to physiologists and pathologists under the name of *atavism*, [German, *Rückschlag*,] explain some of these cases. Lucretius was familiar with this fact, [lib. iv., "De Rerum Naturâ."]

> "Fit quoque, ut interdum similes existere *avorum*
> Possint, et referant *proavorum* sæpe *figuras*,
> Propterea, quia multa modis primordia multis
> Mista suo celant in corpore sæpe parentes,
> Quæ patribus patres tradunt a stirpe profecta:
> Inde Venus varia producit sorte figuras;
> *Majorumque refert voltus, vocesque comasque.*"

Parsons, in the "Physiological Transactions," gives an instance of a black, in Gray's Inn, who married a white woman, who bore him a daughter resembling the mother in features, and as fair in all respects, except that the right buttock and thigh were as black as the father's. The same author mentions a black who married an Englishwoman, the child who was born to them was quite black. He also mentions the fact of two black parents having a white child. The mother was terrified, fearing her husband should suspect her chastity. The father, however, said he was not surprised, as his own father was a white man, although, said he, "my grandfather and grandmother were both as black as you and myself, and although we came from the place where no white people were ever seen, yet there was always a white child in every family that belonged to us." ["Phil. Trans.," vol. lv.]

Supposititious Children.

One child may be substituted for another; medical evidence would be of little service in such a case, unless the ages materially differed, or one child had peculiar marks. *A woman may, however, pretend that she has recently been delivered.* A medical examination would easily detect this, if made at the time. Dr. Cheevers mentions the case of an Indian midwife, *Mussarnat Janoo*, who took away a woman's child, did away with it, and pretended to lie in herself. The midwives and civil surgeon who examined her declared that she presented no sign of recent delivery. She was sentenced to seven years' imprisonment. ("Med. Jur. for India," p. 512.) Two such cases, *Reg.* v. *Skepelhorne and Wife*, and *Reg.* v. *Mary Hall*, were tried in 1870, besides the *Wicklow Peerage case.*

Some remarks on the question of *likeness* will be found at pages 661, &c.

Affiliation Cases.

The evidence in these cases is chiefly circumstantial. Proof of *access* may be given. In a recent case in Queen's Bench, February, 1870 (*Renorf* v. *Eden*), a milliner sued the defendant for seduction. They met in Guernsey, and the defendant left the island on April 15, 1876, and did not return. The plaintiff's child was born 307 days after (February 15, 1868), Drs. Tanner and Clark deposed that they had known cases of pregnancy extending to 297 or 300 days. Drs. Tyler Smith and Barnes stated that although not absolutely impossible that the period of gestation might extend to 300 days, it was so improbable as to be practically incredible. The verdict was for the plaintiff, but it did not depend on the medical evidence, but rather on the fact that the defendant induced her to leave her mother's roof [Taylor, *loc. cit.*, p. 270]. In Appenzal, Switzerland, there was a question in a bastardy case, which of two men, both of whom had intercourse with the mother within seventeen days, should be considered the father! The court postponed the case in order that *likeness to the father* might develop itself! Dr. Taylor justly says that both should have contributed to the child's support. The same author quotes this curious case from the "Lancet," of March 13, 1847, p. 336: Two men, A. and B., had intercourse, unknown to each other, with a young woman in delicate health. This went on for some years, when she was delivered of a female child, 279 days after intercourse with A., and 271 days after intercourse with B., thus there were eight days between the two acts of coitus. She did not menstruate in the interval, and is believed to have had no other intercourse. She went her full time, the child was mature and healthy, and she suckled it. When she died, the two men became aware of the mixed intercourse, and both refused to maintain the child. The child was remarkably like the mother, but showed no special resemblance to either supposed father. It is pretty clear, as Dr. Taylor remarks, that there were no medical grounds for affiliating the child to one rather than to the other, as both periods were within the ordinary range of gestation. This must be still more patent when two or more men have intercouse with the same woman on the same day, or at very short intervals of time. It has recently been decided (*see* Taylor, *loc. cit.*, p. 276), that the place of intercourse, in other words the country, where the seduction or coitus occurs, is no bar to paternity, in a legal sense. This seems reasonable, for the same writer remarks, intercourse might take place in Scotland, conception in England, and the birth in Ireland, in these days of rapid travel. In the case of *posthumous children*, where a second marriage occurred soon after the death of the first husband, the second would legally be held to be the father, unless there were very strong proofs from the development and size of the child, or of non-access on the part of the second husband, to relieve him from the duty of maintaining the child.

We have already noted the question whether a woman could have sexual intercourse unconsciously, and conceive without knowing it [p. 739-40]. A similar question may arise as to delivery. "*Is it possible for a woman to be delivered in a state of unconsciousness?*" Both published cases, and the authors' own experience oblige them to answer this question in the *affirmative.* These cases are, however, very rare, and the woman would not be long ignorant that something unusual had happened to her, unless, indeed, she were the subject of puerperal mania, or some other form of insanity. [See next chapter.] Reminding you that several cases have been already given under their several headings, we proceed to quote a few more.

Illustrative Cases.

CASE I. *The Douglass Peerage Case*, 1767-9. [Taylor, vol. ii, p. 273. Beck, *loc. cit.*, p. 270. We quote the case chiefly from the latter.]

Lady Jane Douglass was married August 10th, 1746, to Colonel Stewart. She became pregnant, and this fact was notorious in January, 1748; and on the 10th of July, 1748, *being in her fiftieth year*, she was delivered of twins at Paris. Of these, one named Sholto did not survive to manhood: the other, Archibald, did. Lady Jane, after their birth, miscarried. In process of time both the father and mother died. Their positive declarations had convinced the Duke of Douglass, and he left his dukedom and other estates to his nephew and their son, Archibald, who was the appellant in the cause. The Duke of Hamilton appears to have conducted the prosecution, and at all events the claim was opposed, on the ground that they were suppository children. The cause came up for final adjudication in the House of Lords in 1769, when Lord Chancellor Camden, and Lord Chief Justice Mansfield gave opinions in favour of the appellant. The following extracts from that of Lord Mansfield are interesting, both as to the age at which pregnancy is possible and probable, and as to the *resemblance of children to their parents*:—"Lady Jane became pregnant in October 1747, at the age of forty-nine years, a thing (says he) far from being uncommon, as is attested by physicians of the first rank, and confirmed by daily experience. It is further proved that the elder child, the appellant, was the exact picture of his father, and the child Sholto as like Lady Jane as ever child was like a mother. I have always (said Lord Mansfield) considered likeness as an argument of a child's being the son of a parent, and the rather as the distinction between individuals in the human species is more discernible than in other animals; a man may survey ten thousand people before he sees two faces perfectly alike, and in an army of a hundred thousand men every one may be known from another. If there should be a likeness of features there may be a discriminancy of voice, a difference in the gesture, smile and various other things, whereas a family likeness runs generally through all these, for in everything there is a resemblance, as of features, size, attitude, and action. And here it is a question whether the appellant most resembled his father (Sir John), or the younger Sholto resembled his mother. Many witnesses have sworn to Mr. Douglass being of the same form and make of body as his father; he has been known to be the son of Colonel Stewart by persons who have never seen him before, and is so like his elder brother, the present Sir John Stewart, that except by their age it would be hard to distinguish one from the other. If Sir John Stewart, the most artless of mankind, was actor in the *enlèvement* of Mignon and Saury's children, he did in a few days what the acutest genius could not accomplish for years. He found two children, the one the finished model of himself, and the other the exact picture, in miniature, of Lady Jane. It seems nature had implanted in the children what is not in the parents, for it appears in proof that in size, complexion, stature, attitude, colour of the hair and eyes, nay, and in every other thing, Mignon and his wife, and Saury and his spouse, were, *toto cœlo*, different from and unlike to Sir John Stewart and Lady Jane Douglass." The House of Lords decided in favour of the appellant, only five peers dissenting. ["Collectanea Juridica," London, 1792, vol. ii.,

p. 386.] Beck gives further details of this peer (afterwards Lord Douglass) in a foot-note. There was an interval of 181 years between the birth of the grandfather and the death of the grandson!

CASE II. *The Gardner Peerage Case.*

See before, page 702. Also a copious account in Beck's "Medical Jurisprudence."

CASES III. and IV. The case of *Jardine* of Kinghorn, and *Elder* of Whithorn, both Presbyterian clergymen, will be found at pages 701-2.

CASE V. *Stothard* v. *Aldridge. Paternity fixed by complexion.* [Bail Court, January, 1856, from Dr. Taylor.]

Plaintiff sued defendant for damages for the seduction of his wife. Defendant was a man of colour. The child born of the alleged adulterous intercourse was proved by the medical witness to have been born coloured, and with woolly hair. The husband and wife were both light. This peculiarity fixed the paternity on the black defendant.*

CASE VI. *Protracted Gestation.*

[The *Commonwealth* v. *Horner*, tried in May 1846, in the United States. Reported by Dr. Taylor, p. 269.] The alleged duration of pregnancy was 313 days. The last intercourse was alleged to have been on March 23rd, 1845. The child, a large healthy male, was proved to have been born on the 30th January, 1846. The medical evidence was conflicting. Twelve obstetric physicians were examined. The court decided that, although unusual and improbable, this length of gestation was not impossible—and the jury returned a verdict that the defendant (the supposed father) was really the father of the child. ["Dublin Med. Press," Nov. 4, 1846].

CASE VII. *Protracted Gestation. Dyson* v. *Dyson.*

[Vice-Chancellor's Court, Feb. 18th, 1852. Reported by Dr. Taylor. *See* also "Legal Examiner," Feb. 21st, 1852]. In this case the husband left his wife in Madeira in February, 1849; she returned to England next August. The child whose legitimacy was disputed, was born on January 8th, 1850. In this instance the period of gestation was alleged to be 336 days. The Vice-Chancellor having referred to the *Gardner Peerage case,* declined to make a decree in favour of the legitimacy of the plaintiff.

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* Referring the reader by way of caution to the remarks on *Atavism*, and on *Lusus naturæ*, at p. 820, we quote the following from Titus Andronicus, Act V., Scene 1.:—

> "Peace, tawny slave, half me, and half thy dam!
> Did not thy hue betray whose brat thou art,
> Had nature lent thee but thy mother's look,
> Villain, thou mightst have been an emperor!
> But where the bull and cow are both milk-white,
> They never do beget a coal-black calf."

Case VIII. *Protracted Gestation.*

Luscombe v. *Prettyjohn* [Exeter Summer Assizes, 1840]. This was an action for damages for seduction. The child was born on the 5th December, 1838. The last meeting was 299 days before. On this ground the defendant disputed the paternity, and the judge summed up in his favour. The jury, however, did not concur in this view, and returned a verdict for the plaintiff, thus pronouncing an opinion that the defendant might have been the father of the child, although forty-two weeks and five days had elapsed since the last access. [" Lancet," August, 1840], quoted by Dr. Taylor.

Case IX. *Protracted Gestation. The Commonwealth* v. *Porter* (Cambria County, Pa.).

The defendant was indicted for fornication and bastardy. The prosecutrix, aged twenty-three, stated that she had had intercourse with the defendant on the 24th September, 1842, and with no other person before or subsequently. She was delivered of a child on the 7th August, 1843, *i.e.*, after 317 days', or forty-five weeks' and two days' gestation. She swore that the defendant was the father of the child. The menses ceased about three weeks after intercourse, and only appeared again slightly about five weeks before the child was born. At this time she had pains which continued more or less until her delivery. She first knew that she was pregnant three or four weeks after intercourse. Defendant relied on the length of time, and therefore merely proved his absence, admitting her statement of date. He seduced her under promise of marriage. No imputations were made on her character. The court and jury both took the view that protracted gestation was probable —and found that defendant was father of the child. One of the jurymen said his own wife had gone ten months with one child. [" Amer. Journ. Med. Sciences," Oct. 1845.]

Cases X. and XI. *Proof of Access. Baptismal Registers not relied on· Married persons must not give evidence against the legitimacy of their children.*

In two cases reported by Dr. Taylor, viz., *Cope* v. *Cope* (North Spring Circuit, 1833), and *Morris* v. *Davis* (in 1830, before the Lord Chancellor), these points were raised and settled as above described. In the former, though husband and wife lived fourteen miles apart, and the wife had formed an illicit connection with another man, and both husband and wife regarded her last child (the plaintiff) as illegitimate, and were willing so to testify, Baron Alderson said, " Lord Hardwicke had decided that the mother could not be allowed to give evidence on such a point, as she could not discharge the husband of the birth of the child ; and, *à fortiori*, the husband could not be permitted to discharge himself. Lord Mansfield and Lord Hardwicke had both decided that illegitimacy could be proved only by the fact of there being no marriage, *or by proof of non-access :* and it was held on the ground of decency and morality that the parties themselves should not be allowed to prove non-access after their marriage." " If a child be born in marriage during the lifetime of the husband, that child, in law, is presumed to be legitimate." "If a husband have access, and others at the same time have criminal intimacy with his wife, still a child born in such a case is legitimate in the eye of the law." But if the parties are living separate, and the wife is notoriously living in open adultery, and the husband have opportunities of access, yet under such circumstances, it would be monstrous to suppose that he would avail himself of these,—then the legitimacy of a child so born could not be established." The jury returned a verdict for the plaintiff that he was legitimate. He had been registered in the parish register as illegitimate. In *Morris* v. *Davies*, it was contended that the plaintiff was illegitimate, though born in wedlock. Husband and wife had voluntarily separated, but lived within a short distance of each other. The wife was living in adultery, and the child was born fourteen years after her separation from her husband. She even concealed the child's birth from her husband, and Mr. Morris did not know of its existence for seventeen years. The Lord Chancellor, to whom the case was referred, said that although the husband and wife met occasionally, it so happened that *none of these meetings would correspond with the time requisite for the birth of the child to make it legitimate*—and coupling this with the general bad conduct of the woman, and her open adultery, led him to regard the plaintiff as illegitimate." This was purely on the facts of the case.

Gurney v. *Gurney*, (Vice-Chancellor's Court, May, 1863), was also decided by proof of non-access. In *Plowes* v. *Bossey*, the Vice-Chancellor, February, 1862, decided in favour of a child's legitimacy, because although the husband was in an asylum, the wife [and mother] visited him at the asylum from time to time.

In *Atchley* v. *Sprigg* [January, 1864], Vice-Chancellor Kindersley said that the child of a married woman is, *primâ facie*, legitimate.

Case XII. *A husband has a child of another woman palmed upon him as his own.* [From Dr. Taylor, *loc. cit.*, 233.]

Regina v. *Skepelhorne and wife*, [Central Criminal Court, February, 1870]. The prisoners were charged with conspiring to deceive a man called Ironside, by falsely representing that his wife had given birth to a female child. Mrs. Ironside, who had been married about nine months, was in collusion with the prisoners. She and they got the child of another woman, and the nurse got a "sheep's pluck" to represent the after-birth—which they afterwards burnt! Dr. Taylor justly says that medical men must not consider all stains on bedding or marks of blood in a room as conclusive! In his charge to the jury, Justice Byles remarked on the enormity of the crime—when large estates and the rights of legitimate heirs were concerned. He thought, however, Mrs. Ironside did it mainly to please her husband! The prisoners were convicted.

Case XIII. *A Supposititious Child detected by the Nurse—and the Mother detected by a Medical Examination.* [Reported by Dr. Taylor, p. 233.] *Reg.* v. *Mary Hall.* [C.C.C., December, 1870].

The prisoner conspired with a woman to make it appear that she had been delivered of a child. The nurse was not allowed to be present during the alleged delivery—the prisoner acting as midwife. The nurse was then called in and shown by prisoner the usual marks of a recent delivery. On proceeding to wash the child, she found this had already been done, and that it was not a newly-born unwashed child. It was proved that the prisoner on this very day procured the child of another woman. On this point a medical man gave evidence. Dr. Farre said he attended the woman after the alleged birth, and from what he saw he was sure that she had never given birth to a child. He then charged her and the prisoner with fraud. The prisoner was convicted.

Case XIV. *The Wicklow Peerage* case. [Committee for Privileges, April 1, 1870. Reported by Dr. Taylor.]

The title and estates of the Earl of Wicklow passed at his death to his brother's issue. The first in succession was George Howard, who, after a career of dissipation, had died in October, 1864. He had been married in February, 1863, to Ellen Richardson, a coachman's daughter. In default of issue the estates devolved on his brother Charles, the second in succession. Ellen Howard (neé Richardson), produced a male child, who, she alleged, was born on the 16th May, 1864, and who, if such were the case, would be the son of her husband, George Howard, and the rightful Earl. Mrs. Howard was at that time in lodgings, and the lodging-house keepers, Mr. and Mrs. Bloor, and a sister of the latter, one Rosa Day, were the principal witnesses in favour of the claimant. Mrs. Howard was, or professed to be, taken suddenly ill at the date mentioned. Mr. Bloor went for a doctor, who was not at home, and on returning, he was told that Mrs. Howard had been confined, and he saw an infant in Rosa Day's arms. This was the whole of the evidence for the child's parentage. The Lord Chancellor observed that the evidence was given by the witnesses with a firmness of demeanour, and an absence of hesitation which would have commanded credence, unless it had been contradicted by all the surrounding circumstances. No medical man, and no nurse attended Mrs. Howard, although it was her first confinement, and the infant would have been a seven months' child. It was never registered and never baptized. There was further strong evidence that she had not borne a child, and that the child which she had produced as her own was obtained by her in August, 1864, from a girl who had been recently delivered in the Liverpool workhouse. Mrs. Howard was clearly identified as the person who had taken away a child from the workhouse at this time. Her story was thus proved to be false. The House of Lords decided against the claim, and came to the conclusion that the witnesses had been guilty of perjury.

In the case of *Gedney* v. *Smith* (Roll's Court, November, 1864), for details of which we must refer to Dr. Taylor (*loc. cit.*, p. 234), one medical man with his wife appears to have assisted in the fraud—and another who was called in appears to have been extremely superficial in his examinations, for although he was attending Mrs. Gedney for a recent confinement, it appeared from the subsequent post-mortem examination (four years after) that she had never been pregnant at all! Be thorough in your examinations!

CHAPTER XXVII.

Unsoundness of mind, congenital and acquired—Its varieties, and medico-legal aspects—Feigned insanity—Directions for examining real or supposed lunatics, and for certifying their condition—Feigned diseases and malingering—The capacity to make a will—Directions for will-making.

There is, perhaps, no subject in legal medicine in which medical men make so poor a figure in the witness-box as that of insanity. This ought not to be, because their daily practice should make them more conversant with the varied phenomena of mind than the members of any other profession. They have, as a body, access to all classes, at all hours, from birth to burial, and amidst a variety of circumstances which ought to give them a vast advantage over most other observers. Several reasons might be given why their evidence so often appears at a disadvantage in courts of law.

(1) The first reason which occurs to us will, thanks to the improved regulations of examining bodies, shortly be only a matter of history. It is, that in former days, so few medical students studied insanity at all. When a glaring instance occurred in their practice, they simply sent it to an asylum as quickly as possible, and dismissed the subject from their minds.

(2) A second reason (also, we hope, soon to be a relic of the past) has been the deficient preliminary education of many members of our profession. Not only has logic, as a formal study, been entirely omitted from the early studies of not a few medical men, but their minds were not even strengthened by studies (like botany or chemistry), which would, by their orderly arrangements, have constituted a good mental discipline. Even the Latin Grammar and Anatomy, which might have partially supplied these deficiencies, were too often merely learnt by rote, or slurred over in the most perfunctory manner.

(3) A third reason must be found in the extreme difficulty of the subject itself, and the want of general agreement amongst those who have studied it most. As we shall presently see, the boundary lines between mental soundness and insanity are often extremely thin, and incapable of precise definition. Religious fervour, the fire of genius, and the energy of ambition are all, at times, so near an approach to madness, that some great authorities have pronounced all men of genius, and nearly all successful conquerors, to have been madmen. Nor is the notion so utterly wild as it might at first sight appear. The great Napoleon had spectral illusions, was subject to epileptic fits, and to attacks of such extreme mental depression, that even now it may well be doubted if he were not at times insane. Turner, the great painter, behaved like a madman in regard to his money, and was as indifferent to many of the decencies of life as any lunatic.

(4) In the fourth place, if our profession has been, and still is, too ignorant as to mental phenomena, there can be little doubt that the general public, and a great many members of the legal profession, even in high places, have been still more so.

(5) Even if judges and counsel are competent, by their knowledge, to form just decisions on the cases brought before them, we must remember that in many cases they have no choice but to administer the law as it stands. And our criminal law, especially on the point of legal responsibility, does, no doubt, bear with extreme hardness on the accused, whilst as regards property, there is often extreme laxity, at least in the interpretation of the law, lest what are termed "the liberty of the subject" and "the rights of property" should be interfered with.

(6.) Those who have made a special study of insanity, are sometimes a little too prone to a sort of scholastic hair-splitting, and too ready to admit the insanity of those who perpetrate crime, as if it were an admitted legal maxim that all crime is insanity, and as if it were always and inevitably true that all the offspring or relations of a lunatic are insane. On a subject so vast, we can do little more than give a few hints, cautions, and directions, by due attention to which you will, we trust, be saved from making any serious mistakes. As an introduction to the legal relations of the subject, we must make a few general observations, and lay down a few propositions.

I. Our first proposition is, *that there may be great and important differences between one mind and another without constituting insanity.* Whole nations and races may thus differ. The logical mind of the old Greeks, of the modern Germans, and lowland Scotch, must not be looked for either in the average Englishman, or in the vast majority of Celtic or Latin races. Yet ancient Romans, Frenchmen, Italians, and Englishmen, have all distinguished themselves in logical studies. This difference may be intensified by education and habits. Great classical scholars may be ignorant of almost the rudiments of figures. A great mathematician may be incapable of classical studies. The great anatomist and physiologist, John Hunter, could not, or at least never did, learn to spell properly. And great bankers and financiers are not all like Rogers, equally versed in the principles of poetry and painting.

II. Whilst it is quite true that the majority of criminals present a low standard of mental development, and a still lower standard of mental acquirements, when judged by what is called "the educational test," it is by no means so clear that these two circumstances stand in the relation of cause and effect. It is a fact that in France,* 83 per cent. of those accused of the crime of infanticide from 1826 to 1850, and 79 per cent. in the fifteen years subsequent, were almost completely illiterate. It does not, however, appear, after correcting for population, that there is any diminution of this crime corresponding to improved education. This point is, however, difficult to settle, as greater efforts are made to detect crime—and railways and telegraphs, and the publicity of the press, probably render detection more easy.

III. We must never forget that the boundary between mental sanity and insanity, between reason, or health of mind and the opposite conditions, is often but faintly marked; circumstances often determine the light in which we should regard an action. A man commits suicide by deliberately throwing himself in front of an express train, and we call him a madman; another man rushes into the same danger to save a child, and we rightly esteem him a hero, whether he succeeds or dies in the attempt. Yet the act was the same in both cases, and although in the latter the motive may be a noble one, it is probable that, in many instances, the act is done almost purely from impulse, with less reflection and less reason than in the case of the suicide.

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* Tardieu, *loc cit.*, p. 7.

IV. We must remember that a very large majority of cases of mental unsoundness are accompanied by changes in the bodily health. The ancient association of a "Mens sana," with a "corpus sanum," is undoubtedly true in a vast number of cases. We must, however, whilst fully admitting this, and acting upon it both for remedial and medico-legal purposes, be careful not to strain this corporeal theory of psychoses too far. Not only books [like Dr. Moore's "Power of the Mind over the Body,"] but our daily experience show us, that the mind often retains its vigour amidst the ravages of bodily decay and disease,* and that it is also true that there may be unsoundness of mind where the bodily health appears good, and where our present means of investigation show no flaw in the corporeal structure. The "theory of *reflex action*" may be perfectly true as regards the operations of our minds, but as yet we know little or nothing, except in the most superficial manner, of either the mechanism, or the workings of the brain. We see the effects, but the causes are often concealed from us. Mental operations may be to a great extent automatic, but this does not exclude the idea of the intervention of a *vis regulatrix.* In fact, the whole of our legal and social relations are founded on the theory that in health there is such a regulating or controlling power, or will, which renders us responsible to ourselves, to one another, to our country and its laws, and finally to our Maker.†

V. Whilst our standard of mental health, or the reverse, must be mainly dependent upon the general average, yet remembering our first proposition, practically expressed in the proverb, "Many men, many minds," we must not forget that each man is "a law unto himself," and that in estimating the present state of a man's mind (as in regard to making a will and the like), he should be compared not only with the general standard, which, in a mixed population such as that of our large cities, must be somewhat vague—but also with what he was—and perhaps in some instances, with what he might have been, had circumstances been favourable. In other words, the man must be compared with himself.

Remember that mental unsoundness on one point or subject does not always and invariably mean insanity on all points. Whether law-makers or law administrators like it or not, it is perfectly certain that there is such a thing as monomania, which, in certain cases, takes the form of moral insanity. In other words, a man may be perfectly capable of managing business, his brain may have all its intellectual vigour, and yet he may be morally unsound—he may feel unreasonable hate towards those he ought to love—and this moral unsoundness may lead him into crime.

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* "The soul's dark cottage, battered and decayed,
Lets in new light, through chinks that time has made;
Stronger by weakness, wiser men become,
As they draw near to their eternal home.
Leaving the old, both worlds at once they view,
That stand upon the threshold of the new."—WALLER.

† "Non nobis solum nati sumus, ortusque nostri partem patria vindicat, partem amici; atque ut placet Stoicis, quæ in terris gignuntur, ad usum hominum omnia creari; homines autem hominum causa esse generatos, ut ipsi inter se aliis alii prodesse possent: in hoc naturam debemus ducem sequi, et communes utilitates in medium afferre, mutatione officiorum, dando, accipiendo, tum artibus, tum opera, tum facultatibus, devincire hominum inter homines societatem. Fundamentum est autem justitiæ fides: id est dictorum conventorumque constantia et veritas."—CICERO. *De Officiis*, lib. i. cap. vii.

VI. We must not forget that a very large number of lunatics have what are called "lucid intervals." It is thus possible for a crime to be committed in a moment of madness; whilst the prisoner, when tried, may be, at that moment, perfectly sane.

VII. If, however, we carefully investigate every case on its own merits, and keep the facts observed by us distinct from our opinions, our credit as witnesses will not be impaired, and our opinions will usually command respect, provided that they are founded on the facts, and couched in such language as a well-balanced mind would naturally choose.

Before giving a brief summary of the various forms of mental unsoundness known to the profession, we will briefly notice

The Medico-legal Questions arising out of Insanity.

These are briefly as follows :—

A. A man or woman makes a will, and after the death of the testator [or testatrix] the question arises, "Was he [or she] of sound mind, and capable of managing his [or her] own affairs, and disposing of his [or her] property by will?"

B. A man or woman is rightly or wrongly considered a lunatic by his friends, and you are asked to sign certificates, in order to place him or her in an asylum. Here note that the friends are often reluctant to admit the insanity of their relatives, and that the first step towards insuring the safety of the insane and of their friends must not infrequently be taken by the medical attendant.

C. You will be consulted by parents and guardians as to the mental condition of their children or wards. The heirs to large estates may be feeble-minded, and questions may arise as to their capacity for learning, and as to their ability and fitness to manage their own affairs.

D. A criminal, convicted of some crime against property or persons, may be defended by his counsel or friends with the plea that he [or she] is of unsound mind, and therefore not responsible for the actions which have led to the arrest and trial. This defence has, of late years, been so frequently made in the case of flagitious criminals, that both judges and juries are now very cautious in admitting it, without very good reasons.

E. Persons about to marry sometimes consult you as to the risk incurred from the existence of what is called "hereditary taint."

F. Insanity is sometimes feigned by those who have committed crime, or by idle persons who wish to relieve themselves of the charge of their own maintenance. It is also sometimes falsely alleged against others with a view to deprive them of their civil or legal rights. It is to be hoped that the cases of wrongful detention of sane people in asylums, with which Mr. Charles Read and other novelists of the sensational school have horrified the public, are extremely rare. Yet such things have been, and might happen again.

We can, from our own knowledge, aver that the great majority of those who keep private lunatic asylums in this country are honourable men, who are incapable of the crimes alleged against them by this school of fiction. We do not, however, on this account, hesitate to express our opinion that the system is a bad one which gives the proprietor of an asylum a direct interest in retaining a patient. We are of opinion that lunatics, no matter what their station in life, if they require to be placed in an asylum, should be made inmates of public institutions, either under direct control of the state or under supervision of the public, like our hospitals for the sick. And the officials should be paid by salary, and not permitted to make a profit out of the individual patient.

G. So far as we know, nearly all the medico-legal questions arising out of insanity are included in the above statement. There may, however, be another case giving rise to legal enquiry, and to reference to medical opinion, viz., A merchant, tradesman, or gentleman of private property, or professional man, may transact business, sign bills, or in some way or other make himself responsible for larger or smaller amounts of money, and the question may arise—Was he sane at the time of transacting such business, &c.? or was he then of unsound mind, and therefore legally irresponsible for such act or acts? Practically, the same question is asked here as in the case of making a will. Indeed, all the cases and questions named may be reduced to the simple statement: Was, or is, A. B. (the person named) at the time mentioned, or at the present time, a person of sound mind, or, on the contrary, a lunatic or person of unsound mind?

i. e. Was, or is, he [or she] sane or insane?

We shall attempt no definition of sanity [of mind]. Like the health of the body, that of the mind admits of many degrees and qualifying terms. There may be sound and robust health, there may be feeble and impaired health of mind, without actual disease or insanity. We shall, therefore, proceed to sketch briefly

The Varieties of Insanity.

Almost every writer on the subject has given his own classification of the varieties of mental disease or unsoundness. Perhaps that of Dr. Skae is one of the best. As, however, no one of these is generally accepted, either by the legal or medical profession, we shall perhaps do best by classifying all the known forms of mental disease under the legal definition given by Lords Coke and Hale:—

Originally the common law of England only included two forms of unsoundness of mind—*idiocy and lunacy*—but Lord Coke recognised four sorts of *non compos mentis,* viz.:—I. *Idiota,* which, from his nativity by a perpetual infirmity, is *non compos mentis.* II. He that by sickness, grief, or other accident, wholly loseth his memory or understanding. [Dementia]. III. A lunatic that hath sometimes his understanding, and sometimes not, *aliquando gaudet lucidis intervallis,* and therefore he is called *non compos mentis* so long as he hath not understanding. IV. Lastly, he that by his own vicious act for a time depriveth himself of his memory and understanding, as he that is drunken. "Lord Hale, in recognising a distinction between general or total, and partial unsoundness, may be said to justify the separation of *monomania* from *mania.* If this be so, we shall find good legal authority for at least four forms of unsoundness. *Idiocy, dementia, mania, and monomania.*" [Guy, *loc. cit.*, p. 161.] Dr. Guy, on this as a basis, proposes to group idiocy, imbecility, and cretinism, under the term of *amentia.* Under *dementia* he would comprise the acute and chronic, or primary and secondary forms, as well as the peculiar state known as *general paralysis.*

And, lastly, *mania* must be made to comprise not only affections of the intellect but also those of the emotions, and must include both a general and a partial unsoundness. The following tabular arrangement represents at one view the fulfilment of these conditions.

Unsoundness of Mind.

Amentia.	*Dementia.*	*Mania.*		
1. Idiocy. 2. Imbecility. 3. Cretinism.	1. Acute, or primary. 2. Chronic, or secondary. 3. Senile dementia. 4. General paralysis of the insane.	1. General. (*Raving incoherence.*		
		2. Intellectual.	General. Partial.	Monomania. Melancholia.
		3. Moral.	General.	
			Partial.	Homicidal. Suicidal, &c.

Dr. Guy only adopts this as a convenient arrangement [*loc. cit.*, p. 162.] Esquirol's classification is simpler, and more nearly corresponds with those given by Lord Coke and Sir Matthew Hale. It is as follows:—1. *Mania.* 2. *Monomania.* 3. *Dementia.* 4. *Idiocy* (Amentia). We shall practically follow this arrangement, for the sake of convenience. Before sketching these typical forms, we reproduce here the classification of Laurent [in his "Étude Médico-légale sur la Simulation de la Folie," Paris, 1866, a monograph to which medical jurists are greatly indebted for clear views of this subject.]

A résumé of the Principal forms of Unsoundness of Mind.

I. Simple forms of mental unsoundness.	1. Maniacal forms.	1. Maniacal excitement. 2. Acute mania. 3. Sub-acute mania, or acute delirium. 4. Chronic mania.
	2. Melancholic forms.	1. Melancholic depression. 2. Melancholia proper. 3. Melancholia with stupidity.
	3. Obscurative form.	Imbecility, or stupidity.
	4. Alternating form.	Alternating mania. Intermittent, or so-called circular madness.
	5. Systematized form.	Monomanias of different kinds.
	6. Enfeeblement, or annihilation of intellect.	1. Simple primitive dementia. 2. Dementia consecutive to simple forms of mania.
II. Mixed forms of mental unsoundness.	1. Neurotic, or hypochondriacal mania. 2. Hysterical mania. 3. Epileptic mania.	
III. Complicated forms of mental unsoundness, properly called organic.	1. General paralysis [of the insane]. 2. Toxic, or specific forms of insanity. 3. Cachectic insanity. 4. Insanity symptomatic of localised lesions of more or less severity and importance.	

Before entering on the descriptive sketches of the commoner forms of insanity, we will reproduce from page 96 of Marce's "Traité Pratique des Maladies Mentales" his excellent Table of the

Causes of Insanity.

PREDISPOSING CAUSES.	*General.*	Civilisation. Religious notions. Political events [or ideas.]	
	Individual.	Hereditary (*i. e.*: defects or instability handed down from ancestors). Age. Sex. Climate. Civil state. Profession. Education.	
OCCASIONAL OR PROXIMATE CAUSES.	*Of moral kind.*	1. Emotions, passions, disappointments. 2. Imitation. 3. Solitary confinement.	
	Of physical nature.	1. Local,	1. *Acting directly in the brain itself.* 2. *Acting at a distance, and sympathetically :*
		2. General.	1. *Anœmias, cachexiæ, seminal losses (onanism.)* 2. *Diathesis, dartres (or eruptions), rheumatism, typhoid fevers, intermittent fevers, etc.*
		3. Physiological.	*Menstruation, pregnancy, delivery, lactation, &c.*
		4. Specific.	*Poisoning [lead, mercury, opium, Indian hemp, belladonna,—other poisonous solanaceæ.]*

It will be seen that *traumatic* causes are only indirectly included in this Table. There is, however, abundant evidence that *injuries to the head*, with their consequent results to the brain and nervous system, are very common predisposing and sometimes exciting causes of mental disease. It is, however, probable that every such case, if carefully investigated, would show other causes, such as hereditary ones, or intemperance; as is well known to be the case with a large majority of the instances in which there is a history of an accident.

Civilisation is indirectly a cause in more ways than one, as (1) by the keenness of the struggle for existence in populous communities; (2) by the severity of competitive examinations, or the eagerness of the competition for places of honour in examination-lists, and for posts of profit or distinction in the professions; (3) By the difficulties in the way of early marriages, and the social vices thereby encouraged. Onanism and other sexual excesses prove doubly injurious, because there is not only physical exhaustion, but also in most cases fierce struggles with conscience. So terrible is this struggle that many of the victims elect to be unsexed [by castration and the like] in the vain hope of getting free from the bondage of sensuality by such means ; (4) By encouraging social emulation in the way of expensive dress, costly banquets, and ruinous expenditure, as in horse-racing, and other forms of gambling, including the Stock Exchange, and other ways too numerous to mention.

Religion is enumerated by nearly all writers on insanity as a cause. Whilst true piety, or the possession of that "peace of God, which is higher than all understanding," has a far different effect, tending to tranquillize the mind amidst "the wreck of matter and the crash of worlds," all who have watched what are called "Religious Revivals" cannot have failed to notice that not a few feeble minds are thrown off their balance at such periods. Such was the case in the Crusades. Not children only, but grown-up persons, started for the East, not only without preparation of any kind, but without even enquiring which way to travel ! The preaching of Rowland Hill, of Whitfield, the Wesleys, and of other more modern revivalists, though useful to the whole nation in rousing its dormant spiritual life, sent not a few to the asylums.* It has been noticed too, that small religious communities, such as the Society of Friends [commonly nick-named *Quakers*], send a disproportionate number of their professors to asylums, compared with larger religious bodies. The explanation is probably to be sought in other causes than their doctrines. Inter-marriages in a limited society, the keen pursuits of mercantile enterprize, and the virtual prohibition of musical and dramatic entertainments, of the fine arts, and of dancing and other so-called "worldly" amusements ; as well as that habitual repression of the emotions which was the habit of the earlier Friends, may possibly be the true factors.† Although certain forms of religious thought and religious emotion thus tend to produce mental disease, all who have carefully watched the treatment of the insane in well-regulated asylums will corroborate what Griesinger ‡ says of the tranquillizing effect of appropriate religious exercises and ministrations amongst the insane.

As to *politics* and *political excitement* we need simply refer to the great increase of lunacy during, and just after, the "reign of terror" in the French Revolution, at the close of the eighteenth century.

When we come to the individual causes, *Heredity* justly takes a first place. Burrows speaks of $\frac{6}{7}$ths of the cases as due to hereditary predisposition. Moreau goes further still, and speaks of $\frac{9}{10}$ths of the cases as so influenced. Although these independent estimates nearly agree, they are apparently not actually based on statistics drawn from any great number of cases. Griesinger gives the following:—In about half the cases, according to Brierre, and at Colditz, and amongst the rich according to Esquirol. In $\frac{1}{3}$rd to $\frac{1}{4}$th the cases, according to Hagen, Damerow, Martini, amongst the poor according to Esquirol, Guislain, Dagonet [in Stephensfeld], Webster, [Bedlam], Skae [Morningside, Edinburgh], and Bini [Florence.] In $\frac{1}{5}$th to $\frac{1}{7}$th of the cases, according to Bergmann and Hagan [as regards *direct* transmission], Fleming, Parchappe, and in the Bloomingdale Asylum, New York. Less than $\frac{1}{7}$th [$\frac{1}{11}$th to $\frac{1}{23}$rd], Jacobi, old statistics of Bicêtre and Salpetrière, Marseilles Asylum, Jarvis from 87,808 English and Irish cases in 1850. The statistics from small numbers, which are probably most carefully collected, give the largest number of such cases. In the Friends' Retreat, at York, direct transmission in $\frac{1}{3}$rd, indirect in $\frac{1}{6}$th, both together in $\frac{1}{2}$ the cases. According to Esquirol and Baillarger, insanity is more often transmitted (indeed about $\frac{1}{3}$rd oftener) from the mother than from the father to the children. This tallies with the observation so often made that clever women have distinguished sons more often than clever men.

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* The authors trust that no one will misunderstand their meaning. Those who wish for examples should read "Hecker's Religious Epidemics of the Middle Ages." These "by-products" of religious revivals suggest caution to those who originate and conduct such movements ; but they do not prove the revivals themselves to be evils.

† The English aristocracy, and that of other countries, and the Jewish community, also exhibit the same disproportionate number of lunatics, compared with equal numbers outside.

‡ "Mental Pathology and Therapeutics." Translated by Drs. Lockhart Robertson and Rutherford. New Sydenham Society, p. 490.

As to *age*, puberty, adolescence, middle life, and the grand climacteric appear to be the ages most predisposed to insanity. Your medical knowledge will give you many reasons for this. Excepting idiocy, childhood is remarkably exempt from insanity, although almost all forms of mental disease are met with in children. Asylum statistics are somewhat misleading on the point of age. But Zeller gives twenty to thirty for males, and thirty to forty for females as the most common ages for the commencement of insanity. Most authorities will agree with Parchappe that from forty to fifty [when sexual vigour is declining, and cares and responsibilities are increasing with diminishing strength] is a more common age in women. In men too, "middle life" is a favourite time for the commencement of these and other neuroses—partly for the same reasons as in women. *Climate*, the *seasons*, *nationality*, (or Race) and *social position* may all prove predisposing causes. We have, however, no accurate statistics on these points, except as regards the numbers in asylums in different civilised countries. Some of these we will state briefly. In Rhenish Prussia, 1 in 1027 of the inhabitants, [in 1828]. Jacobi states it more recently as 1 in 666. In Saxony [in 1836], 1 in 968. In all the German countries together, Griesinger assumes it to be about 1 in 500. In France, according to old statistics, 1 in 1900; according to Brierie 1 in 1000; a more recent calculation gives 1 in 795 inhabitants (year 1852). In Holland (in 1850) 1 to 1000. Schröder van der Kolk thinks 1 in 800 more correct. In England, Scotland, and Ireland there were in 1847, 41,810 patients in asylums.* The proportion is estimated as 1 in 500 for Wales, above 1 in 300 (including idiots) for England and Wales together. [Dr. Tuke, in the year 1858.] For Scotland, 1 in 390. In Ireland, 1 in 569. In Norway (in 1855) 1 in 239 inhabitants. In the United States of America it was calculated that in 1849, there was 1 insane in 500 inhabitants. In Massachusetts, in 1854, including idiots, 1 in 302 inhabitants.

The influence of the *civil state* and *profession*, or *occupation*, deserves more study than has yet been given to it. What are commonly called professions (church, army, navy, law, physic, &c.,) furnish many inmates to asylums, on account of the keen competition for advancement and promotion, disappointed hopes, and a scale of living disproportionate to their means. Still more from the use of alcohol and narcotics to stimulate or rest over-tired and over-worked brains. Agricultural pursuits afford an undue proportion of lunatics to public asylums. It would almost seem that mental stagnation is worse than over-excitement. The real reason is, perhaps, the same which leads to the prevalence of sedentary occupations in the list of the employments of those who become insane. The over-crowding of some avocations, as in the case of governesses and females employed in teaching, is very likely the reason that so many become insane. Sexual excesses, remorse, and alcohol combine to render insanity common amongst prostitutes.

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* As 90,000 lunatics are reported for 1875, the proportion is probably much larger now in the British Islands.

Education has been supposed to conduce to insanity. No doubt, over-stimulation of the intellect in early childhood has an injurious effect. There are, however, no trustworthy statistics on this point.

If we now turn to the immediate occasioning causes, those of the moral order, *emotions*, *passions*, *disappointments*, *imitation*, and the effects of *solitary confinement*, need not detain us, as their influence is either self-evident, or too familiar to need illustration. The last cause named is clearly a complex one—solitary confinement has an injurious effect on the general health, and those who undergo it, are usually either great criminals, or unsuccessful politicians. The physical causes enumerated in the table also need no lengthy discussion here, as some are obvious, and others (such as the influence of puerperal causes, and the effects of poisons (lead, mercury, opium, &c.,) will again be mentioned under the different forms of lunacy or unsound mind. We therefore proceed to sketch briefly the characters of the different forms of insanity, enumerated in the table at page 832. For these word-pictures, or rather sketches, we are greatly indebted to the excellent work of Dr. Armand Laurent, previously quoted, whose classification we substantially adopt.

I. Of simple forms of insanity.

A. *Varieties of Mania.* In general terms, it may be said that when we speak of mania, unless we qualify it by such terms as melancholic, or speak of monomania, or in some other way qualify the term, we imply excitement. For obvious reasons, if we exclude idiocy and cretinism, forms of insanity with excitement will chiefly prevail amongst the younger inmates of asylums. In *mania* (from *μαίνομαι*, to rage) the reasoning faculty is not generally lost, but disturbed and confused; ideas flow through the mind with inconceivable rapidity; they are abundant, erroneous, absurd, wandering, and not under control. Yet, as M. Falret has observed, the incoherence is far more apparent than real—thought is more rapid than its manifestation, and there is often a connecting link between what, at first sight, appear the most incongruous ideas. Just as—

> "The poet's eye, in a fine frenzy rolling,
> Wanders from earth to heaven, from heaven to earth:"—

so maniacs dart from one subject to another with bewildering rapidity. Ignorant doctors and magistrates have even been known to regard the language of some of our great poets and dramatists as evidences of insanity. You must be careful not to mistake the enthusiasm of genius, or even simple eccentricity, for mania. An actor rehearsing his part, a barrister or public orator composing a speech, must not be considered mad merely because they gesticulate, or talk aloud. Yet when a man so far forgets himself as to draw after him a mob of boys, of whose presence he is oblivious, we may conclude that his mental health is a little impaired, though he may not be mad. Shortly before the late Lord Lyttelton put an end to his life, he was seen speaking excitedly, and wildly waving a stick in the Strand, at mid-day. In maniacs the intellect and the emotions are too active—memory recalls events and words, and ideas long unremembered. The imagination becomes so active that even prosy people become eloquent. The maniac is so loquacious that you cannot check his speech—he is emphatic, declamatory, and mingles abusive and obscene or blasphemous words with the most pious reflections. The most modest females will use the vilest words. German alienists call this rapidity of thought "the flight of ideas :—*Ideenflucht*." The voice becomes hoarse—the skin is dry and hot—the countenance has a wild, brilliant expression—and there is often a fixed stare. The movements of maniacs are brusque, disorderly, and incessant—they dance, cry, run, jump, laugh, break things, tear their clothes, or pull them off—and exhibit enormous strength. They generally eat enormously. Urine and fæces are often passed involuntarily, though the bowels are usually constipated. The pulse is rapid, the respirations and temperature above normal in most cases. Perspiration is generally abundant and sour. There is frequently sexual excitement, particularly in females. When this is the chief feature the term *Erotomania* (including satyriasis, in males, and nymphomania, in females) is applied to the insanity. The above is a general description, but Esquirol justly says, "Where is the man who would dare to flatter himself that he had observed, and could describe all the symptoms of mania, even in a single case? The maniac is a Proteus, who, assuming all forms, escapes the observation of the most practised and watchful eye."

Puerperal mania has presented many peculiar features. There are several distinct forms, such as maniacal, melancholic, amatory, and the like; but in general terms it may be said that it is an affection showing itself very soon after childbirth—often as early as the fourth or fifth day. The secretions are generally suppressed. In many cases there is a tendency to suicide or child-murder. Hence the infant, if living, must be taken from the mother for its own safety. "In the cases I have seen," says Dr. Tanner, "there has been great debility, either from floodings during their labours, or by the presence of a morbid poison—as that of erysipelas—in the system, or by some other cause which has lowered their vital powers." There is often great anæmia. The disease is most common in primiparæ, and a large proportion of the cases may be cured by proper treatment.

B. *Monomania*, or partial insanity, has been much disputed, but in reality is a well-marked variety, although often difficult to recognise. In this the subjects of it are often sane upon all points but one. Where a delusion seems two-fold, it will generally be found that the two delusions can be ranged under the same class of ideas. *Religious mania*, though often melancholic, may be considered a monomania. Such patients are seldom violent, unless they meet with opposition. One monomaniac will insist that he is made of *glass*; another that he is a bad half-crown; another that he is possessed by a devil; whilst a fourth believes that he is one of the persons of the Trinity. Such lunatics often make the most absurd demands. Dr. Tanner quotes a characteristic letter from a monomaniac to Dr. Conolly:—

"In the name of the Most High, Eternal, Almighty God of Heaven, Earth, and Space, I command you to procure me the following articles immediately: a 'Holy Bible,' with engravings, &c.; a 'Concordance;' a 'Martyrology,' with plates; some other religious books; a late 'Geographical Grammar;' a 'Modern Gazetteer,' newspapers, magazines, almanacks, &c., of any kind or daté; musical instruments and music; large plans, guides, maps, directories," [and many other works, concluding with] "wines, fruit, lozenges, tobacco, snuff, oysters, money—everything fitting to Almighty God. Answer this in three days, or you go to hell. P.S.—A portable desk and stationery, and a dressing-case."

Mr. Cowper had a letter put into his hands at the gate of the London Hospital from a female religious monomaniac. She addressed it:—

"To the Medical Gentleman of the London Hospital," (*sic*), and it was marked "From a prodeston," [protestant]. It begins by a rambling statement about lady-doctresses, and goes on, "throo them meny men are made unocks, but are ashamed to say so, the way this is don, the way this is don, there is a small hole made in the purs, and by means of homeparti medecon the purs is draned of its contence." After a quantity of rambling matter, the words, "God is love," and "a prodeston" being written across the page, and in several other places, she ends with—"they caused my famely to be pretty well all martered, and my mother the grand-daughter of the hold nobility, and my father the grandson and son of one of the richest famelys of *lanchester*, and I have had nothen, but people to try to take my biseness away to leve me in distress and poverty, and keep me and my famely are kept out of property in gemaker that brought in thirty-five thousands per yer.

"Yours affect, A. P——."

Across the page was written—"You must make the medical-men of the navy acquainted with this, as there is a good deal of property at stake of a captain of the royal navy a grate huncle."

The persecution alluded to was said to be "to satisfy a set of in furiated irish people hoo thought to get up a better breed of people than english!" In another place she says, "You must excuse the spelling, as I Cannot spare time to Correct it on a Count of giving so much away."

In M. Tardieu's "Étude Médico-légale sur la Folie," there are a number of *fac-simile* letters from lunatics of different kinds, some of these are very curious. But some examples will be found in most works on insanity.

Monomania is no medical novelty. It has been recognised from the earliest times, as might easily be proved by references to the writings of the classical authors of almost every country. It is, however, more to our purpose to note that Zacchias ["Quæstiones Medico-legales," lib. ii., tit. 1, quæst. 3], wrote "Non omnes dementes circa omnia errare, quosdam enim circa omnia, quosdam circa plura, alios vero circa pauca quædam solummodo errare constat. *Imo ex illis nonnulli sunt, qui in nulla re, si unum tantum excipias, errant, sed omnia prudenter vel ut ex naturâ mos est, operantur,*" and he gives the following case: One who wished to examine for himself the varieties of insanity, went to a hospital where there were lunatics, and seeing a man of intellectual appearance, he spoke to him, and explained his wishes. The man took him all round the building and pointed out one inmate after another, commenting on their delusions, and explaining everything with great clearness and propriety. At last they came to a man who was sad and thoughtful-looking. The stranger asked his guide from what kind of madness this man suffered. Then said his guide: "This man is deranged in many ways, for he thinks that he is the Holy Spirit. But oh, how he deceives himself! It is I, I who am here before him, who am the Holy Spirit, really and truly!" And this was the sole illusion of the guide.

There is a pretty general agreement amongst the chief authorities on insanity, both past and present, on this subject of monomania. Some, like Baillarger and Griesinger, think that there is a certain amount of mental feebleness with most monomaniacs. Laurent gives a remarkable case of a man who was furious when anyone doubted that he was the pope. He had been the terror of one asylum, but under proper treatment became one of the quietest and most useful inmates of another asylum. Even there, however, if his being the pope was doubted, he became furious again.

The principal forms of monomania are: (1) *Monomania of ambition*, or delirium of grandeur. This is probably often confounded with general paralysis of the insane, to be mentioned presently, as the delirium is the same. (2) *Religious monomania.* The medical witness should acquaint himself with the doctrines and rites of various religious bodies and sects. It may otherwise easily happen to him, if inexperienced, to confound peculiar religious dogmas or practices with mental unsoundness. Dancing, for example, is a religious ceremony amongst the Shakers, and amongst many African and Indian tribes. (3) *Erotic monomania* [ἔρως, love], or insanity on sexual topics. (4) *Monomania of disease* (Nosomania, νόσος, disease). As an example, people sane on every other point will believe that they have syphilis (when they have no sign of it), or that they have some worm or reptile in their stomach, or some other disease of which they present no symptom. (5) *The monomania of persecutions*, in which, without cause, the person affected believes that he or she is being constantly watched by spies, or followed by enemies, who are constantly plotting his or her destruction. The persecution is imagined to be either from his own family, or from the circle of his acquaintance, or from Government. The latter form is most prevalent on the Continent, where espionage is, or at least was, so frequent and customary a matter as to be a natural object of dread. (6) *Kleptomania* (κλέπτω, to steal), is an irresistible desire to pilfer or appropriate the property of others. As this defence is now often made when ladies or persons of education and position are accused of stealing, we think it fair to state, (*a*) That we believe there can be no reasonable doubt as to the existence of this form, though it is happily rare; the first king of Sweden was subject to it; a sad case occurred a few years ago in the wife of an obstetric physician. Her case was not purely monomania, as she had had puerperal insanity on several occasions. But there are cases of this propensity known in their own family circles, known also to medical men, and some of them inmates of asylums, which are unknown to the general public, and would diminish the rarity of these cases if published. (β) It will generally be found, in genuine cases, that the habit is not suddenly acquired, or if it be so, some adequate reasons can generally be established for its sudden occurrence, such as impaired general health, disorders of the sexual system, with hæmorrhages, in females (*e.g.*, child-birth, metrorrhagia, prolonged lactation, &c.), or some great trouble, loss of relatives, or nervous shock of other kinds. These cases are more common in females. (γ) Insanity in some member of the family will often be found to render hereditary tendency probable. (7) *Autophomania* (Αὐτοφόνος, a self-murderer), commonly known as suicidal mania, and *Homicidal mania* [Androphomania, ἀνὴρ, a man, φονεύω, to kill], or the tendency to kill others, are forms of insanity very familiar to alienists. They are, however, very difficult problems for the medico-legists. We believe that when these cases are carefully examined into, it will be found that the rule is, that the impulse has not been so sudden as it seems at first sight to be. It will often be found that the suicide, or furious murderer has told some one of his intention long before, or has manifested some aberration of intellect or emotions before the last horrible act of the tragedy. We shall recur to this in discussing the question of *responsibility for crime.* Suicide appears most common amongst educated people. The proportion of suicides in England and Wales to the population, has maintained a pretty constant ratio since 1858, when these deaths were made a separate class in the returns of the Registrar-General. In that year 1,275 such deaths were returned. In 1874, there were 1,592 in England and Wales. The annual number was 67 per 1,000,000 persons living in the three quinquenniads 1864, 1869, and 1874. In 1873 the proportions were 65 per million for rural districts, and 83 for London. The 1,592 deaths by suicide in 1874 included 1,204 of males, and 388 of females; and besides 133 from various or ill-defined causes, there were from hanging 597; from incised wounds (chiefly cut-throat) 340; from drowning, 280; from poison, 149; from gunshot wounds, 93. In Wales there were only 39 suicides to the million ["British Medical Journal," June 10, 1876]. (9) *Moral insanity,* which as yet has been scarcely admitted by any of our judges, as a defence in regard to crimes such as murder, does yet undoubtedly exist. In glaring instances, when no legal issue depends on it, it will often be admitted by others than specialists. In this form of madness, whilst the intellect appears to be unaffected in all other matters, "there is a perversion of all natural feelings and affections of temper, habits, and moral disposition," as Dr. Tanner well says. A daughter hates a most affectionate mother for no reason at all [though she will sometimes give many supposed reasons]. A husband all at once or more gradually begins to hate his wife and children causelessly. A previously moral man becomes a debauchee. It is seen at once that to distinguish between sin and madness, is very difficult in some of these cases. In many of them alcoholism and the use of narcotics may partially explain. In some cases of moral insanity other neuroses are combined—hysterical and epileptic fits may be found co-existing with the so-called moral insanity, by careful investigation. (10) *Pyromania* [πῦρ, fire], or the tendency to set fire to houses or other property, is a monomania difficult to class. Rick-burning, and the attempt to set dwelling-houses on fire are often the acts of precocious children, or of young people of both sexes about the age of puberty, or within a few years of it. [From ten to twenty-five years of age being most common in these cases.]

C. *Melancholia* or lypemania [λύπη, grief], though ranked with other forms of mania or acute insanity, differs from them in many important particulars. It is seldom so sudden in its onset, unless when the effect of some profound mental or moral shock. Instead of being a state of mental exaltation and excitement, it is one of intense depression. This state has been variously divided by systematic nosologists. The slighter forms hardly amount to insanity, and are called *melancholic depression.* All the ideas are gloomy, but there are few delusions, if any at all. Yet there is a loss of energy. The subjects of it are unable to take pleasure in anything. They seek to be alone, their appetite is diminished, digestion is slow, constipation is generally present, their sleep is unrefreshing, and they are generally weak and anæmic. Great actors, public orators, and others, who undergo great fatigue to amuse the public, are subject to this form of depression.* The poet Cowper suffered from it, at the very time that he wrote "John Gilpin." Carlini, a French comic actor, consulted a physician for attacks of profound melancholia. The physician, not knowing him, said, "Go and see the Italian comedy. Your distemper must be rooted indeed if the acting of the *lively Carlini* does not remove it." "Alas," said the miserable patient, "I am the *very Carlini* whom you recommend me to see, and while I am capable of filling Paris with mirth and laughter, I am myself the dejected victim of melancholy and chagrin," [quoted by Dr. Tuke from Prefect's "Annals of Insanity," p. 404]. Similar anecdotes are given of Quin, Foot, Grimaldi, and other actors. When melancholic depression deepens into true *melancholia,* it assumes three principal forms. (1) *The religious,* into which Cowper's depression deepened, from which also very few men of strong religious feelings have been exempt. The names of Luther, Melancthon, Colonel Gardiner, Cotton Mather, President Edwards, Rowland Hill, and many others amongst Protestants; of Fénélon, Madame Guyon, and the Quietists, and of Ignatius Loyola, amongst Roman Catholics, may be mentioned as suffering from more or less melancholia at times; Spinosa also suffered from similar attacks. Very lively descriptions of future punishment, such as are common in great revivals of religion, predispose to this form of madness. As may be imagined, those of strong religious feelings are most disposed to it. (2) A second form called *hypochondriacal melancholia* [ὑπό, under, χόνδρος, cartilage], is generally marked by strange delusions and perverted sensations. Pope in his, "Rape of the Lock" [Canto iv.], mentions these as follows:

> "Unnumbered throngs on every side are seen,
> Of bodies changed to various forms by spleen:
> Here living tea-pots stand, one arm held out,
> One bent, the handle this, and that the spout;
> A pipkin there, like Homer's tripod, walks;
> Here sighs a jar, and there a goose-pie talks,
> Men prove with child, as powerful fancy works,
> And maids, turned bottles, call aloud for corks!"

Strange as many of these delusions seem, still stranger ones are constantly met with. Some of these cases may leave us doubtful whether to rank them with monomania, or in this class of melancholia. In the former, however, there is an absence of the sadness which characterises this latter. General paralysis [of the insane] sometimes assumes a melancholic form. In extreme cases of melancholia, the patients will not look up, keep their head bent, almost between their knees, do not care to take food, or to attend to the decencies of dress, &c. In addition to constipation and dyspepsia, these patients frequently have chronic disease of the lungs, liver, or kidneys [M. Brightii], and degenerated arteries. Dark-haired races and dark-haired people are most subject to melancholia, hence what is now often called the pigmentary diathesis, or bilious temperament, is sometimes called the "melancholic temperament." Hypochondriacs are sometimes free from all delusions, except those as to their own health. "To be hipped," "to have the spleen," "to be dying of ennui," are phrases sometimes applied to this condition. (3) The *nostalgic* form of melancholia [νόστος, bringing home, ἄλγος, grief], is applied to that (sometimes epidemic) insane longing for home, attended by melancholy, which attacks soldiers, sailors, and other young people who are away from their own homes.* The *Ranz des Vaches* was long forbidden in Swiss regiments, because when played, the Swiss deserted in numbers to return to their native hills and valleys, or died of grief if unable to do so.

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* "He makes his heart a prey to black despair;
He eats not, drinks not, sleeps not, has no use
Of anything but thought; or, if he talks,
'Tis to himself."—DRYDEN.

Lastly, melancholia may be combined with a torpid or stupid state, in which the will appears entirely in abeyance. [M. Delasiauve in the "Journal de Médecine Mentale," tome I.]

D. *Alternating mania*, the so-called circular or rotating madness, is a peculiar form of insanity, specially described by M. Falret, in which periods of excitement (or mania) alternate with periods of depression (melancholia), with occasionally perfectly lucid intervals. This is generally included under mania in English books on the subject. The authors, however, from their own experience, consider this a well-marked clinical variety of insanity. They know instances in which the interval is as long as two or three months. Take the following case as an example :—"Mr. B—— entered the navy as a midshipman in the merchant service. Off the coast of Africa he had a sun-stroke, and after that some kind of tropical fever. In his delirium he insulted his captain, who first struck him on the head with an iron bar, then put him into irons, on deck, in the tropics, still exposed to the sun, and kept him on bread and water for a fortnight. At the end of this time he was seen to be raving mad, and was then treated as such. Ever since (though then only fifteen, and now forty-five) he has been subject to fierce paroxysms of maniacal excitement, followed by depression; and these attacks by a long lucid interval, which has sometimes been as long as six months, though more often only six weeks. In the intervals he is fond of, and trusted by and with children. He is well educated and accomplished. In his paroxysms he seems more like a devil than a man. Hardly any cell can contain him. He is violent and destructive. He knows when these attacks are coming on, and so do those accustomed to him."

E. *Under the names of Stupidity*, *Dementia*, and the like, are included cases in which there is for a longer or shorter time (weeks, months, or years), a state in which the intellectual powers or faculties are temporarily suspended, without marked melancholy, though there is sometimes a sort of sadness. The head seems swollen, the whole attitude is stupid, the eyes lack lustre, the countenance is pale and dull, the attitude fixed. External stimuli and noises make little or no impression. Sensibility is blunted, urine and fæces pass involuntarily, saliva dribbles from the mouth, the will is in abeyance. These patients neither hunger nor thirst; they must be fed, dressed, put to bed, &c. All their wants are automatic and instinctive. Except for obstinate constipation, digestion is pretty good. Some few emaciate, but most are tolerably well nourished. The catamenia in females are generally suspended. Strange as it may seem, these cases, when uncomplicated by paralysis, or organic diseases, in other words when acute, usually recover, either suddenly or slowly.

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* The Dutch, Swiss, Highlanders, and the Irish are said to be most subject to nostalgia.

F. *Chronic mania*, or systematized insanity, is that state which supervenes upon the acute form when that is not cured. The bodily functions are somewhat improved, the mental powers are less fiercely excited, though there is still the same confusion of thought, the same want of self-control, but less rapid flow of ideas than we meet with in acute mania. This state is unhappily but seldom cured. It subsides into dementia, or some other chronic form of mental feebleness.

G. Simple *dementia* (*de*, privative, *mens*, the mind) is generally consecutive to mania, or melancholia, though sometimes produced by accidents and mental shock. It is a condition of which weakness of the intellect is the most prominent feature. Very extreme age is, we think, wrongly considered to be one of the causes. Dr. Tanner's description can hardly be surpassed :—"The mind is altogether feeble, the ideas confused, vague, and wandering, and the memory is impaired. There are paroxysms of restlessness and excitement. The patients are ignorant of time, place, quantity, property, &c. They forget in a moment what they have just seen or heard. Their manners are undecided, childish, and silly; their conversation is incoherent; and they repeat words and entire sentences without attaching any precise meaning to them. They have neither partialities, nor aversions; neither hatred, nor tenderness. They see their best friends and relatives without pleasure, and they leave them without regret. Sometimes they are constantly, but slowly, moving about, as if seeking for something; on other occasions they will pass days in the same place, and almost in the same attitude. They have little or no control over the bladder or rectum; while the phosphates of the urine are diminished in quantity. It is very rarely, if ever, cured; and in its last stage there is complete paralysis. Cerebral atrophy is a constant concomitant of dementia, its extent varying with the loss of mental power.

II. Under the term "*Mixed Forms of Insanity*," the French and other continental psychologists include those varieties of insanity which are complicated by other neuroses. Of these there are two principal varieties :—

H. *Hysterical mania*, which, as its name (ὑστέρα, the womb or uterus) implies, is most common in the female sex. It is very difficult to define the exact boundaries between the neurosis (often spinal) called hysteria, in which the emotions overpower the will, which is associated with a tendency to laugh and cry immoderately, and with a feeling of suffocation, *globus hystericus* (often due to flatulence) in the throat,[*] and its combination with insanity in the form of mania. Indeed, it is often difficult to distinguish between hysterical and epileptic attacks, except we agree that only those associated with complete loss of consciousness, shall be called epilectic. Existing spinal neuroses may give rise to insanity. Sir B. Brodie ("Lectures on Certain Local Nervous Affections," London, 1837, p. 8) tells of a lady who for a year suffered from permanent spasm of the sterno-mastoid muscle. Suddenly this ceased, and she became melancholic. The melancholia lasted a year, when her mental health returned; but the muscular convulsion returned also, and continued for several years. He reports another case, in which a neuralgic state of the spinal column alternated with true insanity. The hysterical disposition is marked by immoderate sensitiveness (betokened by tremulous eyelids, tremor of other muscles, tendency to sudden pallor or blushing, inclination to laugh, cry, scream, &c.), especially sensitiveness to the slightest reproach; tendency to refer everything to themselves, great irritability, great change of disposition on the least, or even from no external motive (humours, caprices); and not the slightest reason can be given for the change. They often exhibit tender sympathy for other females, peculiar eccentricities, very lively intellects (in young girls, pleasure in learning, &c.). This general state comprises many peculiarities of character, often of quite another kind, as tendency to deception and prevarication, to all kinds of misdemeanours, jealousy, malice, &c. [Griesinger, "New Sydenham Society's Translation," p. 179.] Though rare in the male sex, hysteria is less rare in men than is generally supposed. Hysterical mania is marked by the inconstancy and variety of the symptoms, which are truly Protean. The patients are by turns calm, furious, melancholy, loquacious, dumb, stupid, a prey to hallucinations, possessed of the devil, erotomaniacs, feeble-minded, deceptive, libertines, thievish! [Laurent, *loc. cit.*, p. 191.] In females we generally find, as M. Delasiauve insists so strongly, some disorder of menstruation [amenorrhœa, dysmenorrhœa, menorrhagia, metrorrhagia, &c.]. Hysterical mania has prevailed epidemically at various times. One of the most recent epidemics was at Morzine, in Savoy, described by Dr. Constant.[†]

Young medical men can scarcely be too much on their guard in the treatment of female patients suffering from marked forms of hysteria, especially when there are any tendencies to erotic mania.

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[*] Hysteria is called "Fits of the mother;" *μήτηρ*, = mother: hence *μήτρα*, the womb. Latin, *mater*, *matrix*. So in King Lear:—

> "Oh, how this mother swells up towards my heart!
> *Hysterica passio!* down, thou climbing sorrow!
> Thy element's below."—Act II., Scene 4.

[†] A. Constant, "Relation sur une épidémie d'hystéro-démonopathie observée en 1861." Paris, 1863. Consult on this point Hecker's "Epidemics," &c.: and M. Calmeil, "De la Folie Considéré sous le point de vue Pathologique, Philosophique, Historique et Judiciaire," &c.; M. Tardieu, *loc. cit.*, p. 159, Legrand du Saulle; "Étude Médico Legale sur l'Hystéric," &c.; "Gazette des Hôpitaux," Dec. 1859, p. 145; Morel, "Traité de Maladies Mentales," 1860, p. 691: Moreau, "De Tours Union Médicale," 1865; Bulard, "Thèses de Montpellier," 1858; Lachaud, "Thèses de Paris," 1857; Delasiauve, "Journal de Mèdicale Mentale," tom. ii., p. 242. Dr. Gueanneau de Mussy has shown that the children of gouty parents are particularly prone to neuroses.

I. *Epileptic mania* (ἐπί, upon; λαμβάνω, I seize) is another mixed form. It is well known that frequent fits of epilepsy have a tendency to weaken the intellect. To preserve the moral and mental faculties unimpaired after many epileptic seizures, if not impossible, is yet extremely rare. The instances of Julius Cæsar, Napoléon Buonaparte, and the Duke of Wellington, sometimes quoted, do not disprove this rule, as their attacks were separated from each other by long intervals. Napoleon only saw *l'homme rouge* on the eve of his great battles. According to Suetonius most of Cæsar's attacks were what we should call *le petit mal*, and only some two of them real epileptic fits.* M. Morel divides epileptic mania into three periods. The first is one of extreme irritability and impatience of contradiction, sometimes greatly to their own disadvantage. There are fears as to their own health, unjust recriminations, strongly pronounced venereal tendencies. There is a peculiarly *dangerous character* in these disordered conditions of epileptics. Their general health is more affected than that of only hypochondriacal or hysterical patients. In this first period the disorders of digestion and circulation are often severe, and it is very common for the patients to be troubled with hallucinations of the senses. They often have tendencies to suicide, homicide, and incendiarism. In the second period, they are generally to be found in asylums, their rage and irritability having passed ordinary bounds. A word or a gesture is enough to irritate them. They can't bear even to be looked at. There is great venous congestion, the eyes are brilliant, and sparkle with anger. Yet a single word will often calm them again. They will come to the doctor, or visitor, as if they had some great secret to communicate. It is nearly always a complaint or invective against some one, often marked by the most outrageous falsehood and exaggeration. They are timid and cowardly, and though they seem ready to fight at any moment, nothing comes of it. Fear of punishment leads them to retire alone to make their complaints, and utter their threats, perhaps gesticulating wildly in some lonely alley. The epileptic character is irritable, perfidious, and deceitful, all in one. It is sometimes marked by noble sentiments, extreme religious fervour, lively protestations of zeal and devotion, and yet with all this, there is deep cunning, and the most outrageous acts. All these tendencies are periodical, like the disorders of the intellect. Celorum, an epileptic maniac who murdered Dr. Geoffry, when attacked by his fits of mania, justified his crime. In the intervals he regretted it. During the second period we have described, the insanity may take different forms—mania, melancholia, dementia, &c. The alternations of madness and lucid intervals are very rapid. Epileptics of southern races are especially prone to furious madness.

There is a sudden kind of insanity known by the name of temporary insanity, instantaneous madness, larval or masked epilepsy, which may occur in persons whose epilepsy is unknown, or at all events not recognizable when their actions cause enquiry. Murders committed in this state may not be remembered when the attack is over.† In relation to this we must not forget that epilepsy is often feigned. See the remarks on this, in the paragraph on Feigned Diseases. In the third stage of epileptic mania, there is more and more delirium, and it goes on into dementia and general paralysis. The convulsions become more frequent —the intellect more feeble—choreaic movements and muscular tremors supervene. Speech becomes incoherent and unintelligible from defective phonation. They become hemiplegic, and more and more paralyzed until death closes the scene.

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* "Valetudine prospera: nisi quod tempore extremo, repente animo linqui, atque etiam per somnum exterreri solebat. *Comitiali quoque morbo bis inter res agendas correptus est.*"—C. SUET. TRANQ., lib. i., c. 45. The Emperor Napoleon III., in his "Life of Cæsar," combats the idea that these were epileptic fits; but we think he has not established any good reason for doubting the common opinion.

† Morel ("Gazette Hebdomadaire," 1860), "La Folie devant les Tribunaux,"

J. *General Paralysis* [of the insane] is one of those complicated forms of insanity which often gives rise to medico-legal questions. It is now frequently seen in hospitals as well as asylums, but we must briefly sketch its leading features. It is most common in the male sex, and after forty years of age. Immoderate use of alcohol, opium, tobacco, or other narcotics, venereal excesses and syphilis are said to be common causes. There is (1) a delirium or state of delusions which usually has the character of ambitious ideas [Delirium of Grandeur]—in which the patient fancies himself the strongest, richest, bravest, most talented and most fortunate of men—but sometimes the delirium may be maniacal, melancholic, or hypochondriacal. (2) The intellectual powers are weakened—this may at first be overlooked on account of the singular form of the delusions. (3) There are disorders of motility, in other words, pareses of peculiar kinds.

The first thing generally noticed is some change of character. MM. Falret and Linas admit four distinct varieties—the expansive, the melancholic, the paralytic, and the congestive. Of these the expansive is the most common. Those affected begin to live irregularly, they quit their homes, wander about, and give most extensive orders to tradesmen [a dozen dress-coats, a hundred pairs of shoes, £2000 or £3000 worth of wine, for example, ordered by a man of small means]. They will sometimes undress and lie down in the open air instead of going to bed; go to hotels and live at extravagant rates, take cabs without having money to pay for them, or enter into ruinous speculations. They may even commit objectless thefts. The delusion as to grandeur, and enormous wealth, which has been considered characteristic of this form, is certainly the commonest delusion. There is, however, no system in their erroneous ideas, and this distinguishes their delusions from those of monomaniacs. General paralytics are remarkable for the peculiar nature of their ambitious ideas, which are absurd, constantly changing, multiple, and contradictory. An officer thus afflicted said he was going to marry the Empress Eugénie (her husband was then alive), but five minutes afterwards he had resolved to marry Queen Victoria instead. In a few minutes more he informed us that he proposed to take possession of the seraglio of the Sultan. The memory, reasoning powers, and logical sense are profoundly impaired in these cases. They willingly give up their opinions if contradicted, pass from one idea to another, are sad and gay by turns, forget the false ideas of yesterday, and when asked, mingle the real events of their past life with their delusions, with no sense of incongruity, or of the shocking contradictions of their account. Some of them live in an imaginary heaven of their own, their contentment is affected by nothing that happens. They pretend to be great writers, great poets, statesmen,

p. 357, from Dr. Legrand du Saulle. See also Trousseau's "Clinical Lectures," Dr. Bazire's translation, vol. i., p. 19, Lectures II. and III.

to be the strongest men alive, &c. But sometimes melancholy ideas are mingled with these notions of grandeur and riches. And hypochondriacal ideas may also be associated with the melancholy.

The muscular system affords very valuable indications. There are little shuddering or shivering movements of the facial muscles. There is a difficulty of articulation, particularly as regards labials [P, B, F, M, &c.,] owing to the tremor and irregular contraction of the muscles of the lips, tongue, face, and lower jaw. If asked to hold the tongue out of the mouth this tremor is very evident. This embarrassed speech is most marked when they are excited, after eating, during menstruation, etc. There are automatic movements of the muscles of the mouth and lower jaw. The pupils are generally unequal [M. Baillarger]. The muscles of the upper and lower extremities are affected. This paralysis is Progressive, Incomplete, General—hence the letters P, I, G, have been adopted as an aid to the memory [Dr. Down]. There is one form in which there is paralysis of this kind without marked delusions. [*Paralytic form.*] In the congestive variety the general paralysis seems to supervene on obscure premonitory symptoms by cerebral congestion resembling apoplexy. When these acute symptoms pass off, maniacal excitement and ambitious ideas make their appearance. There is sometimes apparent recovery, but the intellect is enfeebled, and has lost its clearness and vigour. This variety progresses by fits and starts. There is a peculiar physiognomy. The capillaries are dilated, almost varicose, and the face is red, swollen, and fiery. In the second stage the patients live in a constant state of slight excitement, alternating with irregular paroxysms of more violent agitation. The excitement is automatic. Meanwhile the troubles of motility increase. Sometimes there is spasmodic contraction of certain sets of muscles. Whilst strength is diminishing, digestion seems to go on well, and the appetite is often ravenous. They will seize their food with their fingers. In the third stage they get very stout, and the quantity of food taken augments the risks of cerebral congestion. The rectum and bladder become paralysed. There is first retention, and then incontinence of both urine and fæces. In the later stages, they are troubled with constipation, diarrhœa, retention, œdema of extremities, troublesome ulcers, boils and bed-sores, sanguineous tumours in the ears (hæmatomata auris). The patients fall into a state of marasmus, unless carried off by gangrene, apoplexy, or some inter-current complication. The paralysis is not so much mere want of force—it is want of co-ordination, and want of muscular sense. The muscles do not generally undergo fatty degeneration, and they usually retain their electric contractility even in the bed-ridden. Aubanel distinguishes several forms of cerebral congestion, as (1) a slight form with excitement; (2) a maniacal form; (3) a convulsive one; (4) a hemiplegic form; (5) apoplectic or hæmorrhagic; (6) comatose; (7) intermittent; (8) an irregular form with alternations of these various symptoms. Whilst nearly all the cases die in from eighteen months to three years, there are a few cases of apparent cure, and many of remissions. Dr. Sauze says that in one form, the paralysis goes, and dementia remains; in a second there is paralysis, whilst the intellect is little affected. In the third form both the paralysis and the mental condition improve. These remissions are very variable in their duration. Epileptic and hysterical mania and other forms of insanity are sometimes followed by general paralysis not unlike that we have already sketched in its general features, but distinguished from it in being secondary instead of primary.

K. *Toxic or specific forms of mania.* The disorders of intellect due to alcohol, lead, mercury, tobacco, opium, Indian hemp, belladonna, and other poisons have been briefly alluded to under their respective headings. There are some symptoms common to all of them. Queer crawling feelings in the skin (formication), tremors (particularly of the tongue), cramps, convulsions, and paralysis, are common to all of them when these poisons have been taken for a long time to excess. As to *alcohol*, the earlier stages of drunkenness strikingly resemble mania, in its acute form. *Delirium tremens* is familiar to medical practitioners, and therefore need not detain us here. It is a form of temporary insanity, marked by muscular tremors, and delusions chiefly affecting the optic nerves, though the sense of hearing sometimes participates, and sometimes other sensory nerves; the hallucinations or unreal objects of terror are in general small, dark, ugly, and disagreeable. (Beetles, rats, more rarely policemen, devils, &c.) There is sleeplessness, and the delirium is often of a busy kind. The man wants to be at work in his shop, or farm, or counting-house, &c. There are intervals of depression and moroseness, or of abject terror. Under the names of *chronic alcoholism*, and *alcoholic mania*, a variety of conditions have been described. In one case we get *general paralysis* of the insane, in another there is *acute mania* with *suicidal* or *homicidal* tendencies. In a third there is dementia or enfeeblement of all the mental powers. Yet nearly all of them have the common symptoms of muscular tremors, want of sleep, queer crawling sensations affecting the skin, hallucinations as to the presence of dark, disagreeable objects, muscular weakness, spasms, convulsions, want of co-ordination of muscles, incoherence of speech and ideas, and feeble powers of volition.

When *lead* has produced insanity, we shall find besides the blue line on the gums and other symptoms of plumbism [*see* Acetate of Lead, p. 191], a delirium of dread, strikingly like that produced by alcohol, but chiefly noticed at night; convulsions of an epileptic character, and tendency to coma. MM. Jules Falret and Delasiauve have seen general paralysis follow lead poisoning.

Mercury will produce similar symptoms. Perhaps the muscular system is more weakened than even by lead. The methyl compounds of mercury in poisonous doses produce furious delirium and death. Two such cases happened in the laboratory of St. Bartholomew's Hospital.

Other metals are known to sometimes cause delirium and convulsions. It is possible that some cases of insanity may be due to their ingestion in some form or another. *Belladonna*, other solanaceous plants (as *Datura stramonium*, and *D. tatula*, *hyoscyamus*, &c.), *conium*, *Indian hemp*, *ergot of rye*, *tobacco*, and *opium*, all in their turn, have the property of causing acute delirium, temporary insanity, and by their long-continued use, general paralysis, chronic manias, and dementia What is called "running a muck" amongst the Malays is supposed to be due to the use of *bhang*, a preparation of *Indian hemp*. But some two or three years ago an instance occurred at the quiet region of Prawle's Point, Devonshire. The crew of an Italian barque had landed there, having abandoned their ship in consequence of a collision. Seven of the foreigners were lodged in one room of the little inn, and all were sleeping peacefully in the village, when suddenly a great outcry arose from the room of the Italians. The landlord went to the door of this room, and opened it, to find six of the seamen hiding under beds and boxes from the fury of one of their number, who was brandishing a long knife, and endeavouring to kill them. The door was no sooner open, than he made a rush at the landlord, who turned the key, and went for assistance, returning with two coastguards. When they opened the door, the furious Italian darted out and stabbed one of the coastguards in several places, rolling downstairs with his victim. Rising to his feet, the maddened creature sprang from the house, and rushed down the village street, meeting the wife of the very man he had just stabbed, and inflicting fearful injuries upon her. Still furiously running, he came to the coastguard station, and when the door was opened in answer to his knock, he pounced upon a sailor living there, on whom he inflicted twelve separate wounds. This sailor's wife came to his assistance, and he struck her, and would probably have killed her, but that by this time the knife was blunted. The son of this couple grappled with him, and flung him over a wall. He then tried to make his escape. Three sailors, with cutlasses and lanterns, pursued him, and he flung himself upon them once more, and was kept off by a sword-stick. Again he dashed at them, when their officer came up; but at last he was killed in the melée. It was said that he was always violent; and that on this occasion he was maddened by drink. It is said that *pellagra*, a skin disease common in Italy, sometimes induces this fury, at other times a condition more like delirium tremens.

L. *Idiocy* [ἰδιώτης, unskilled, or private, because unfit for intercourse with the world] differs from the conditions we have just described, because it is either congenital, *i.e.*, born with its subject, or induced by diseases or accidents happening in very early periods of life. Whereas the maniac or the demented have been rich, and are poor in mental gifts; the idiot is one who never has been rich. Of the causes of idiocy we cannot speak at any great length. Marriages of consanguinity, accidents and diseases during gestation and parturition,* and diseases of early infant life (rickets, syphilis, tuberculosis, struma, convulsions in dentition, &c. &c.), and intemperance in the parents, especially as regards the father (Dr. Down insists greatly on this), are all considered predisposing causes.

In the idiot the mind is not developed. There are no ideas, or but few. The countenance is vacant, and void of intelligence; the manners childish, with occasional gusts of passion; the gait and articulation are often imperfect. Much has been done of late years in training idiots, at institutions like Earlswood, or those of Dr. Down in England, Seguin in America, and Guggenbühl, and the Abbé Sicard in Europe. Occasionally idiots recover after accidents to the head. Dr. Pritchard speaks of three boys who were idiots. One received a severe injury to the head, and he improved so much, that he became a barrister. The other two continued idiots. Van Swieten speaks of a girl who was idiotic, till trephined for a fracture of the skull. She recovered, and became intelligent. Haller and others report similar cases. Dr. Forbes Winslow mentions the case of Father Mabillon, who was said to have been idiotic till twenty-six. He then fractured his skull against a stone staircase by a fall. He was trepanned. After recovering from the effects of the operation and injury, his intellect fully developed itself. He is said subsequently to have exhibited "a mind endowed with a lively imagination, an amazing memory, and a zeal for study rarely equalled."

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* See a paper by Dr. Little, "On the Influence of Abnormal Parturition, &c., on the Mental and Physical Constitution of the Child,'' vol. iii. "Obstetrical Society's Transactions," p. 293. Dr. Mitchell attributes much Scottish idiocy to the use of the forceps.

Some idiots have small heads: these are the majority; and premature ossification of the sutures of the skull has been considered a cause. On the other hand, some idiots have large heads. Hydrocephalus is one cause of idiocy, congenital or acquired.

Dr. Langdon Down, whose experience in these matters is greater than that of any other British physician, insists strongly * that idiocy and imbecility are not diseases of the nervous system only, but "profound diseases, involving almost every organ and system of organs in the body," and essentially modifying growth and development. The principal peculiarities noted by him are the following:—

The *lips* of idiots are generally thick, and often fissured, especially the lower lip: both are deficient in muscular power. So is the *tongue*, although large. The *salivary glands*, including the *tonsils*, are often hypertrophied; hence *dribbling* is common. So is *stammering*. The *palate* is inordinately vaulted; *i. e.* the roof of the mouth is high, and its arch is narrow, or more or less "pointed," like a long ∩ or Λ. The hard palate is often more or less deficient, and the velum or soft palate hangs too forward. The *teeth* are cut late, and irregularly, and decay very early. The *gums* and buccal mucous membrane are often in a state of chronic inflammation. The *lobules of the ears* are generally deficient, or badly developed, so that the ear appears almost continuous with the face. They are frequently subjects of hypermetropia, myopia, and congenital cataract. There is very often strabismus, approximation of the internal canthi, and the presence of semi-lunar folds of integument at the inner angle of the orbit—"Epicanthus." The fingers, and especially the thumbs, are weak, and prehensile power is defective; the sphincters are deficient in tone.

Dr. Langdon Down urges very strongly the value of these physical deviations in a medico-legal point of view. In the very important questions that may arise as to whether the idiocy be congenital, or from accidental causes after birth, he believes the presence of the deviations referred to, especially those of the mouth, enables him to decide that in those that are the subject of them the idiocy must be attributed to causes operating anterior to parturition.

In addition to defective size of brain, and defective grey matter, and want of development of the convolutions, very many post-mortem observations have shown other deficiencies in the nervous system, such as absence of the entire cerebellum, of the pineal gland, of great part of the fornix, of a great part of the olivary bodies, corpora mammillaria, thalamus, and corpus striatum, optic commissure, auditory nerves, and absence or rudimentary state of the corpus callosum and soft commissure. [For references to these cases, see Griesinger, *loc. cit.*, pp. 356, 357.] Deaf-dumbness is common. Some idiots are born deaf, dumb, and blind. On the other hand, this privation of senses did not prevent Laura Bridgman from developing great intelligence under careful training.

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* See on this point his paper, "On the Relation of the Teeth and Mouth to Mental Development," in the "Transactions of the Odontological Society," vol. iv., No. I., November, 1871.

Whilst the higher faculties are wanting in idiots, the lower (love of money, sexual passions, &c.) are often very marked. But the majority of idiots are tractable, and capable of affection. They often exhibit considerable powers of memory and imitative faculties, so as to draw, paint, carve, make ships, &c. Many can sing, who cannot talk plainly.

M. *Cretinism* (supposed to be derived from *cretina*, old Italian for a poor creature), is endemic in some parts of Switzerland, the Tyrol, and other mountainous parts, such as the Carpathians, the Cordilleras, Himmalayas, &c. Strictly speaking, it is rather the inhabitants of the valleys than those who dwell on the hills who suffer. The poor *Cretins* are generally both deaf and dumb, or, at all events, speech and hearing are imperfect. Sight, smell, and touch are also badly developed, or impaired by disease. They present nearly all the symptoms of rickets, and these are accompanied by *goître*, or bronchocele [an exaggeration of the disease called *Derbyshire neck* in England], the enlarged thyroid body forming a tumour, which sometimes attains enormous proportions, and almost reaches the middle of the body. The head is generally disproportionately large [macrocephalic], the features old-looking, the body small, thick-set, and almost childlike ; the lips thick, the eyelids puffy, the nose large, and deeply impressed at its base ; the body is often swollen and puffy-looking, owing to hypertrophy of the skin, and sub-cutaneous-cellular tissue ; the belly is especially big ; in the higher degrees they scarcely resemble human creatures. Their mental life has altogether the character of apathy and torpor ; they are sometimes inclined to outbreaks of savage anger. Rösch and Virchow want to make monstrosities of these ; but Griesinger has shown that it frequently does not commence till after birth, and that in its moderate degrees it is capable of some degree of improvement. We have seen bronchoceles of enormous size in the South of England. The smaller *goîtres* met with in this country do not necessarily impair the intellect. It is, however, to be noted that such patients are always extremely nervous.

The *Aztecs*, formerly exhibited in this country as remnants of an extinct American people, were scarcely idiots in the common sense of the term. They had extremely small heads [microcephalic], with aquiline noses and prognathous features, but their bodies were small and well-proportioned ; and their movements active. Their intelligence was undoubtedly small, but they, and others like them, are lively, happy, clever up to a certain point, capable of affection, but possess little or no capacity for business. Gratiolet has shown that there is premature synostosis of the cranial arch, whilst the basis cranii often remains cartilaginous. The spinal brain [cerebellum, medulla, pons, &c.] is developed out of all proportion to the convolutions. [Griesinger, *loc. cit.*, p. 379.] The extraordinary resemblances presented by the weak-minded to certain birds and mammals has attracted attention from almost time immemorial. These Aztecs resemble birds ; and Pinel gives a case of an idiot girl, aged eleven years, resembling a sheep, in the form of her head, and in her desires and capacities. She ate only vegetable food, said *bé, ma tante*, using no other words. When quarrelling with other children she butted them like a sheep. Her back, shoulders, and loins, were covered with a kind of soft black hair, one to two inches long, resembling wool!

We have already at page 843, partly described, under the names of *dementia, amentia, imbecility, fatuity*, and the like, those terminal forms of mingled mental and bodily weakness, into which all the others, if not cured, or the sufferers released by accident or other diseases, lapse in the course of time. It is said that occasionally we meet with cases of simple primitive dementia, in which there has been no other form of madness or unsoundness of mind antecedent. A curable form has been described at page 842, and really belongs to melancholia [with stupor]. Dementia may follow diseases of the circulatory, respiratory, and secreting organs, degeneration of tissues, and other diseases of the brain. Griesinger quotes Meding [in Siebenhaar "Magazin für die Staatsarzneikunde," I., 1842], as to a case in which a state of complete mental torpor followed three days after a suicidal hanging. The prisoner's age was twenty-five, and he was strong and healthy before. After some weeks he recovered full consciousness and his mental powers, and was quite cured. These recoveries are, however, rare. The vast majority of our asylum patients belong to the class of dementia, consecutive on other forms of mental disease. In these cases there is no special predominance of any one insane idea, although the original character of the madness (erotic, ambitious, religious, melancholy, and other ideas; or hysterical and epileptic fits, homicidal and suicidal tendencies, paralytic states and the like) still stamps their condition with a feeble likeness of their former insane state; yet there is a character of *feebleness* in all they say, or do, or think, resembling idiocy or childishness, or the apathetic state induced by brain diseases and accidents to the skull. *Loss of memory* is generally one of the most striking features. They forget the most simple names, and lose all conception of time,* &c.

A man of genius may forget his own name [Swift, Tom Moore, Samuel Rogers], and the number and names of his children. The long past is more easily remembered than recent events. Hence these demented people are said to have "old men's memories."

Reason, judgment, imagination, perception, and all the rest of the intellectual powers, are also feeble. Their mental horizon is a very small one. If females, they are content

> "To suckle fools and chronicle small beer."

The artist loses his creative genius and his executive power, the mechanic his skill of hand and eye. Such patients usually talk little. They are often indecent, and sometimes disorderly, especially at night. Sometimes their muscular force is retained, and the demented keep on walking, jumping, running, dancing, &c., or occupy themselves in knitting, sewing, scribbling, or some other mechanical occupation By-and-by the simplest propositions cease to be comprehended, and the only answer to questions is some mechanical and parrot-like repetition, or an imbecile and fatuous stare. Such patients are often smiling, amiable, and contented. Some patients of this kind remain fixed in some comfortable or awkward attitude. The will becomes more and more enfeebled.

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* You must not forget, however, that a very large number of sane persons have little or no memory for dates, and small capacity for figures. On the other hand, there was lately an inmate of Earlswood, who could repeat a very large portion of Haydn's "Dictionary of Dates"!

The *acute form of dementia* is known to arise from

(1) Mental shocks [Dr. Guy gives one from the panic of an earthquake, 1843]. In war-times also, from frights and the loss of those dear, even more than in peaceful seasons. Such cases were common in the French " Reign of Terror."

(2) Accidents, especially to the skull, and severe acute diseases, as the exanthemata, will also cause this condition.

(3) Certain poisons (notably methylic mercury compounds, and exposure to extreme heat, insolation, coup de soleil), may do the same.

The *chronic form of dementia* (which, unlike the former, must be considered as nearly always incurable, is induced by

1. *Old age* (*dementia senilis*), although we need hardly tell you that age alone is no necessary cause of insanity. In the early stages of this there is often some excitement. The subjects of it have always been feeble-minded :—Horace's " Garrulus senex," and Shakespeare's " Lear " and " Polonius," offer examples of this stage. In others it is the last infirmity of noble minds.

2. *It supervenes on other forms of insanity.* Thus acute dementia uncured becomes chronic, and the maniac, monomaniac, melancholic, hysterical, epileptic, or general paralytic patient becomes demented. "Second childishness and oblivion" overwhelm him. In the later stages (no matter what the antecedents) we get extreme bodily weakness, general or partial paresis, incontinence of fæces and urine, inability to move from one position, even in bed, or to feed themselves. Bed-sores form ; they get boils and carbuncles. *Blood-tumours form in the ears* (*hæmatomata aurium*), as in general paralysis. They lose sight and hearing, and every other sense, and become in some cases oblivious even of painful sensations [apathetic dementia]. In these the temperature is often very low. Sugar is often found in the urine. Cataracts form. The modes of death are—

(1) By gradual exhaustion or starvation (asthenic mode).

(2) By pulmonary congestions, generally hypostases.

(3) By apoplectic attacks, hæmorrhages into brain, &c., or serous effusion into its cavities or membranes.

(4) Coma from uræmia, or other causes, may set in.

On Delusions, Illusions, Hallucinations, and some other terms used by Psychologists.

We have endeavoured to give you most of the synonyms commonly used for the various forms of insanity. There are, however, a number of terms used in describing these mental states, which require a brief explanation.

Delirium (*de*, from, *lira*, a ridge or furrow [*] , signifies the wandering condition found in fevers, and other acute diseases, in a few chronic ones, in exhausted or weak conditions, such as anæmia, cachexiæ (cancerous, tubercular, &c.); the effects of some accidents, losses of blood, starvation, injuries purposely inflicted, and the like. *Delirium is a temporary condition.* Whilst it lasts, it incapacitates the person affected for business, making a will, and the like; but in the intervals the delirious person is not to be regarded as insane. Delirium may be—

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[*] To make balks in ploughing ; *i.e.* to wander from the subject in hand.

(*a*) *Acute and fierce* (*ferox*), resembling mania: and is met with in the early stage of typhus fever, in acute rheumatism, and insolation when the temperature is very high, in tropical fevers, acute alcoholism, traumatic fevers after wounds, &c., in mental excitement from very bad news, in scarlet fever, meningitis, &c. &c.*

(*β*) *Sub-acute or mild:* the "night-wandering;" and what delirium there is by day in most cases of enteric fever, is of this character. So is that of many other exanthems in people of mild disposition; also in tuberculous, and other exhausting diseases, &c., chronic traumatic fever.

(*γ*) *Low and muttering:* later stages of typhus, exhausting diseases, and those accompanied with hectic in their later stages, in uræmia, &c. &c.

(*δ*) *Busy or active*, but not fierce: many cases of delirium tremens, traumatic delirium, in cerebral fever from mental shock, from certain poisons, &c. &c.

(*ε*) *Hilarious and noisy;* a modification of (*a*), but without violence: alcohol and other poisons, mental shocks.

(*ζ*) *Melancholic:* in fevers, cachexiæ, &c., in persons of a sad temperament. Some cases of chronic alcoholism.

(*η*) *Delirium of dread:* notably in alcoholic, lead, and mercurial poisoning, and in hydrophobia; rats, beetles, mice, policemen, devils, are often accompanying spectres.

(*θ*) *Delirium of grandeurs*, like delusions in general paralysis, and monomanias of pride, ambition, riches, &c., is occasionally met with after accidents, and in febrile diseases. A member of the surgical staff of a large hospital, known to the authors, was attacked with enteric fever, (having previously had scarlet fever), and his delirium precisely resembled that of general paralysis. He was the Earl of Perth, had untold wealth, was amazingly strong, clever, powerful in the cabinet, &c., *whilst he had the fever.* It was noticeable that (although rather ramblingly) he systematized this delusion very like a monomaniac. Reason returned with the defervescence from the fever.

Surgeons and accoucheurs are said to be sometimes temporarily affected with a peculiar delirium of dread, in difficult and protracted cases of operation, or difficult, and complicated, or lingering labours. [M. Guéniot alludes to this in the "Revue Médical," July 3 and 10; also, see "Medical Times and Gazette," Sept. 2, 1876; "La Manie des Opérateurs."

The panics which are sometimes epidemic in regiments, armies, large assemblies, and amongst the inhabitants of large towns, are closely akin to the delirium of dread.

We have before observed that nearly all poisons, notably the vegetable narcotics and narcotico-acrids, are apt to produce delirium. As regards delirium tremens, produced by alcohol, it is well to remember that the shock of severe injuries, or strong mental excitement, will produce symptoms in some delicate children and adults closely resembling delirium from chronic alcoholism.

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* The delirium of poisons, especially that induced by the vegetable narcotics, is often of a fierce kind.

As regards the legal relations of drunkenness, the majority of our judges rather consider it as an aggravation of the crimes committed in this condition than otherwise. But in strict law it has no legal effect upon the offences to which it leads. It neither increases nor mitigates the penalties that attach to crime. [Dr. Guy.]

Illusions are sensations without any corresponding external object. Most persons can, by a strong effort of the will, call to the mind, and bring before the mental eye, the scenes of past pleasures and sorrows, the features of their friends, and the like. They can recall the tones of a song they have heard, the noise of rushing waters, and other sounds, and the perfume of some favourite flower, or of some favourite dish, of which the taste also is remembered. Such mental images, when the sense of sight is concerned, are called *spectral illusions, phantoms, or phantasms.* Those who are quite blind through accident, or disease of the eyes, are able to see these mental *eidola.* The French, and many English authors, use the word *hallucination* [*hallucinor*, to mistake] in a similar sense. Considerable ambiguity of meaning has attached to this word, owing to the loose manner in which it has been employed. *An* illusion *becomes a* "delusion" *when believed in as real.* Brierre de Boismont, Griesinger, and Esquirol use the word *hallucination*, to designate an unreal sensation, wholly due to the action of the brain; and *illusion* to designate a real sensation, exaggerated or distorted by the same operation, such as the "Mirage," or the "Spectre of the Brocken." Other writers, however, do not maintain this distinction. Nicolai, a Berlin bookseller, was for years troubled with seeing unreal objects (spectral illusions), and sometimes by hearing unreal sounds. He did not, however, believe in them. These *illusions* of his were therefore not *delusions.*

The celebrated Pascal, after an accident, always believed he saw a precipice on his left hand, and had a chair placed on that side to prevent his falling over it. With him, therefore, it was a delusion.

To make this still more clear, we will quote Drs. Bucknill aud Tuke:— "*A delusion is a belief in the existence of things which have no existence in reality, or an erroneous perception of the nature of things, or of their relation to each other, occasioned by cerebro-mental disease;*" or again (as Dr. Bucknill defines it), "*An intellectual error caused by the pathological condition of the mind, and displaying itself in false sensation, perception, or conception, is illusion, hallucination, or delusion proper*" (*op. cit.*, 317). Whether a patient be deceived by the illusions of the senses which are presented to him may depend in some cases on the clearness of the image, distinctness of the sound, &c., in others, and by far the greater number of cases, upon the integrity of his powers of reflection, comparison, judgment, &c. Griesinger states that distinguished and highly intellectual men and women, especially those of warm and lively imaginations, are most likely to have hallucinations or illusions. "*Nothing would be more erroneous than to consider a man mentally diseased, because he had hallucinations*" [*loc. cit.*, p. 90]. Yet it is quite certain that these phenomena are most common when the bodily health is slightly impaired. Luther's visions were when suffering from solitary confinement. Pascal's "abyss" appeared after a dangerous fall from the bridge of Neuilly. Spinoza was half-starved. Poets and artists are specially subject to illusions. The names of Sir Walter Scott, Jean Paul, Benvenuto Cellini, Goethe, and many others might be quoted here.*

There has been much discussion on the subject of *dreams* and *dreaming*. It seems now pretty generally agreed amongst physiologists that dreams occur between sleeping and waking, or at all events in disturbed sleep. Also that they are very often the result of slight disturbances of health, such as indigestion, extreme fatigue, &c. Or they are the result of very strong impressions made upon the mind when awake. A sore head has been known to result in a dream of being scalped by Indians. The slamming of a door has suggested the firing of muskets or the roar of artillery. What is called the *nightmare* is more than mere dreaming: there is generally a sense of suffocation. The dreams, on awaking from which the dreamer is seized with fury, and attacks those around him, are probably epileptic states. Those who are truly sane, when roused from sleep, either forget their dreams, or know that they have dreamt, and are fully conscious of the unreality of the visions of sleep. What Dr. Carpenter has called *Unconscious cerebration*, in other words, the mind continuing to work whilst asleep, will partially explain the accounts we hear of difficult mathematical problems being solved in sleep, and of poems being composed in the same condition. Coleridge's "Khubla Khan" was said to owe its origin to this source. The phenomena of *somnambulism*, or sleep-walking, are closely akin to this state. Some of those who walk in their sleep appear to lead a sort of *double* life. Thus Dr. Rae, in his "Treatise on the Medical Jurisprudence of Insanity," speaks of a Carthusian monk, who in the day was simple, honest, and candid, but in his sleep-walking he was a thief, and would even plunder the dead. He speaks of a pious clergyman who plundered his own church in his sleep-walking. Others have suicidal tendencies in this state, whilst others are violent and attempt to commit murder. Dr. Guy quotes from Georget the following case of homicidal somnambulism. A monk, late one evening, entered the prior's room of his convent, his eyes open but fixed, his features frowning, and with a knife in his hand. He walked straight to the bed, and gave three stabs, which penetrated the bedclothes and a mat which served as a mattress. He then returned to his own room, with features relaxed, and a smiling countenance. The next day he confessed, on being questioned, that he had dreamed that his mother had been murdered by the prior, and that her spirit had appeared to him and cried for vengeance; transported with fury at the sight, he ran directly to stab her assassin. Shortly after, he awoke, covered with perspiration, and rejoiced to find that it was only a dream ["Des Maladies Mentales," p. 12].]

Dr. Guy states that attempts have been made to fix the responsibility of acts committed in sleep on the somnambulist when awake, on the ground that the act is only the carrying out of a previously conceived plan. We have, however, no right to assume this, as there are no facts to justify it. If the defence of somnambulism were raised in a case of murder, you must remember that the sleep-walker generally has his eyes open, takes little or no heed of any external objects (although he often skilfully threads his way amongst familiar scenes, and will even unlock doors), and marches straight forward, being generally roused from his abstraction or sleep with great difficulty. The question has been raised whether falls from a height in sleep-walking can be considered suicide in the meaning of life insurance policies. But it has been ruled that the proviso against suicide only includes intentional killing [case of *Borradaile* v. *Hunter*, Common Pleas, May, 1843]. [Dr. Taylor also refers to the "Medical Gazette," vol. xxxvi. p. 826]. The same writer gives a number of instances showing that some persons are furious when first roused from sleep or after a debauch.

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* Consult Esquirol, "Traité d'Aliénation," and several articles in the "Dictionnaire des Sciences Médicales;" Bayle, "Révue Médicale," Jan. 1825: Hibbert, "On Apparitions;" Sir D. Brewster's "Letters on Natural Magic;" Sir W. Scott's "Demonology and Witchcraft;" Brierre de Boismont, "Des Hallucinations." Paris, 1853. Other references will be found in Griesinger (*loc. cit.*, p. 84), and other systematic writers.

Hypnotism or *Braidism*, sometimes called the *mesmeric state* or *mesmeric trance*, is a curious condition into which some persons (mostly females) can be thrown by the influence of others, or by staring long at a fixed bright object or luminous point. Whilst this state lasts their sensations are perverted, and sometimes abnormally acute. The mind seems to be subject to the will of the operator. The authors have seen operations (such as the removal of a breast and amputation of a limb) done on patients in this state, who appeared to feel no pain whatever.

But inasmuch as this and allied conditions have no great importance at the present moment so far as their legal relationships are concerned, the authors feel it would be undesirable to discuss them here in detail. Whatever truth or untruth there may be in them, as yet they are almost entirely in the hands of the ignorant and designing, and have not received the attention of the accurate and scientific observer. It would certainly be no valid defence to the accusation of murder for the criminal to plead that he was under mesmeric influence! We need not therefore discuss these conditions any further in this place.

Catalepsy or *trance* is most likely to become a legal question from its occasional resemblance to death. The tests given in chapter II. will suffice to distinguish these conditions. Although *hysteria* and *epilepsy* are closely allied conditions, catalepsy is not insanity or unsoundness of mind in the legal sense of the term. The expression, "*unsoundness of mind*," is, as Dr. Taylor remarks, rather a legal than a medical phrase. It is, however, an English equivalent for insanity. *Lunacy* (from the supposed influence of the moon, *Luna*) is another term of similar meaning, retained in such expressions as the writ "*de lunatico inquirendo*." Another term, "*lucid* intervals" is clearly derived from *lux*, *lucis*, light, and signifies those periods in which an insane person is free from his insanity or delusions. A remission is a mere abatement of symptoms. In a lucid interval the madman is no longer mad. He is therefore capable of making a will, and is responsible for his acts. These intervals may be longer or shorter, varying from a few hours, or even less, to many months or years. In the latter instance, the insane person would be said to be cured. Mania and monomania, melancholia, and general paralysis are most likely to exhibit lucid intervals. For idiocy and dementia are generally permanent conditions.

"*Non compos mentis*" is another legal term, equivalent to "insanity."

Premonitory Symptoms of Insanity.

Before a previously healthy person becomes insane, we shall generally find—

(1) *Alterations of general health.* For the most part these are degenerations of tissue.

(2) *There are altered or perverted sensations.* The sight, smell, hearing, taste, and other senses are either impaired, or their sensitiveness greatly increased. Thus, as regards *sight*, we get diplopia, chromatopsy, sensations of sparks, or bright light, muscæ volitantes, or amblyopia, hemiopia, and the like;* and objects may appear inordinately large, or inordinately small. The Hon. Mr. Perceval (who wrote the book called "A Personal Narrative," &c.) says that at the commencement of his insanity a boiled fowl first appeared very large and plump, then suddenly small and meagre, afterwards of twice its bulk. He also mistook a red silk handkerchief for one soaked in blood. Some patients see other men uncommonly large (like elephants), or small (like fleas), or "as trees walking." Or images of unreal objects are impressed upon their minds. They hear unreal voices, sometimes urging them to commit crimes; or the slightest noise becomes torture. Others perceive strange smells, or are strongly affected by even pleasant perfumes: hence the phrase, "Die of a rose in aromatic pain." These smells are not always illusions. In some cases decaying bone in the cranium, or elsewhere, has been found after death, when bad smells have been complained of in life. Sometimes there has been insensibility to pain, or the slightest touch has been torture; whilst a firm grasp is not painful (*Algesia*).

(3) In some cases there is loss of muscular power, as in general paralysis of the insane.

(4) There is often sleeplessness.

(5) Great irritability, alterations of temper, excitability, tendency to laugh or cry; suspiciousness, without adequate cause; unreasonable likes and dislikes; sometimes intense *self-conceit* (Dr. Radcliffe), loss of memory, confusion of ideas, inability to think, write, or speak connectedly; a hesitating, slow manner of speaking, or a hurried and continuous torrent of words. These and other changes in intellect, emotions, or behaviour may, severally or collectively, precede decided symptoms of insanity.

(See Dr. Forbes Winslow's "Obscure Diseases of the Brain," p. 88. Also Griesinger, *loc. cit.*, Book I.)

How to Examine Suspected Lunatics.

You may be asked to examine persons supposed to be of unsound mind, or pretending to be such, either with a view to their being placed under restraint or supervision, or in the case of prisoners awaiting trial, or already undergoing sentences. As insanity has been often feigned, very violent methods have at different times been resorted to, to detect the supposed imposture. Amongst these violent or unscientific methods are the actual cautery, flogging (or blows with a cane), starvation, the whirling-chair, and tortures of various kinds, imprisonment in dark rooms, cold baths in winter, and the like. There are some other means which are less violent, and may be considered sometimes justifiable, though not always free from danger, and generally inferior to the methods of scientific diagnosis now used by skilled psychologists. These, sometimes permissible, means are—

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* As regards perception of colours, we must not forget that *Daltonism*, or defective perception of certain colours, is a congenital defect in some persons. For the most part red and green are confounded. In some the defect is so slight as not to affect the perception of what are called "primary colours" (red, blue, yellow, &c.) but only mixed, secondary, or impure colours. Such a condition has been the cause of more than one railway accident and collision at sea.

(1) *Threats*—often useful in the diagnosis of feigned epilepsy.

(2) *The Cold Douche.*

(3) *Alcohol,* pushed to intoxication. It may be queried if this is morally right. It is certainly dangerous, and hardly ever successful.

(4) *Chloroform, Æther, and other Anæsthetics.* These also must be cautiously used, if at all, as not devoid of danger.

(5) *Narcotics,* such as *Opium,* or *Chloral Hydrate, Belladonna,* and *Stramonium.* Also dangerous. Monteggia gave a criminal shamming lunacy six grains of opium in soup, without apparent effect; on another day six grains again, and, six hours after, another six grains. The man did not sleep; but next day he cried out suddenly, "O my God! I am dying!" and after this behaved rationally, and thanked Monteggia for having cured him. The experiment was, however, a very dangerous one.

(6) *The Strait Jacket, or other means of restraint.*

(7) *Blisters.*

(8) *Placing the Suspects with Epileptics or other Lunatics.* This also might end in real insanity.

(9) *Sudden surprises, such as firing off pistols, crackers, &c.* This is a clumsy method at best. If to be used at all, it should be for those who pretend to be *dumb.* It is far inferior to watching the suspects quietly, and visiting them (also quietly) at unsuspected hours.

(10) *Deprivation of Luxuries* (such as tobacco or wine, or meat) in the case of prisoners has occasionally been of use to detect impostors.

Some examples of these methods will be found under the illustrative cases.

It may be said, in general terms, that all these methods (except, perhaps, the use of anæsthetics) are somewhat questionable, and are decidedly inferior to the one about to be described—which is that adopted by the best psychologists in England and on the Continent. The examination divides itself into two parts—the *Direct* and *Indirect.* We will take the latter first.

A. An *Indirect Examination of a real or supposed Lunatic involves*—

An inquiry into his past history and that of his family:

(*a*) If only one parent have been insane, it is less indicative of taint than insanity in a parent and an uncle, or in a brother and sister as well as parent. Insanity on both sides is obviously of vast importance, but less so when only occurring years after the birth of the person examined. This kind of insanity is also important, as puerperal mania in a mother need not necessarily affect a son. Insanity of cousins is not at present considered of much importance. (Dr. Bucknill.)

(*b*) If no insanity be found hereditary, inquire as to other neuroses, such as epilepsy, hysteria, chorea, paralysis, migraine, vertigo, &c., in the supposed lunatic or his family.

(*c*) Ascertain if there has been any change of habits or disposition, or any recent or more remote serious accident or illness. Injuries to the head, syphilis, fevers, sunstroke, &c., are obviously important. So is the existence of renal, pulmonary, and cardiac disease. (See the *premonitory symptoms* just mentioned, page 858.)

(*d*) In the case of a criminal lunatic you will probably have, what is called on the Continent, the "*procès verbal*," or, in English, "*the depositions*," or, at all events, some account of the prisoner's crime. You should inquire as to *previous convictions*, if any. As regards the crime itself (murder, violence, theft, &c.), you will have to consider the mode or manner of it :—Was it sudden? Did it *appear* premeditated, or the reverse? Did any quarrel or provocation precede it? How did the prisoner behave afterwards? Did he attempt to conceal the crime, or himself? &c. (We shall revert to this in dealing with the question of *responsibility* of criminals.)

(*e*) *The letters or other writings* of the supposed lunatic, if any, should be examined. (We have before referred to this.)

B. As regards the *direct* examination of the supposed lunatic, it will be found to include an examination—

(*α*) Of his physiognomy.
(*β*) Of his attitudes and gestures.
(*γ*) Of his words, manner of speaking, and writings.
(*δ*) Of his physical condition, as to sensations, muscular power, and organic functions (digestion, &c.).
(*ε*) Of his mental condition, as tested by careful interrogations, which should be directed (as Guislain well says) in the direction—
  (1) Of amatory ideas.
  (2) Of religious ones.
  (3) Of ideas of property.
  (4) Of ideas of an ambitious kind, and as to his success in life.
  (5) As to ideas on social subjects, and on national, literary, and artistic progress.

The physician will interrogate the various faculties of the intellect. He will ask the patient to give him his own ideas, to reason, use his judgment, and calculate. He will test his memory as deeply as possible. He will address the imagination, the will, and the attention.*

You must not be frightened by all this! Dr. Bucknill has very well summarised the matter in the following excellent rules :—

(1) *Learn as thoroughly as possible the antecedents and history of the patient* [*or criminal*].

(2) *Ascertain if there have been any change of habits or disposition.*

(3) *Exercise the greatest tact and discretion in the personal examination of probably insane patients.*

(4) *Observe any peculiarities of residence or dress.*

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* Guislain (de Gand), "Leçons Orales sur les Phrénopathies," tom. i., p. 35.

(5) *Study the appearances, demeanour, and general conduct of the patient.*

(6) *Notice any peculiarities of bodily condition.*

(7) *Observe any peculiarities of gesture, and the expression of the countenance.*

(8) *In medico-legal cases let the physician avoid becoming a partisan on either side.*

[See also "Hints for Certifying in Cases of Insanity," by Dr. J. S. Bushnan. "Medical Times and Gazette," for August, 1862, and Dr. Millar's valuable "Hints on Insanity."]

The following *cautions as to manner* may be of some use to you, if inexperienced in these matters:—

I. If possible, do not let the supposed lunatic know your real object in the questions.

II. Do not use roughness, at least at first. A quiet gentle manner is more likely to put impostors off their guard.

III. Your natural manner (unless that be a very rough one, which we will not suppose) will usually be the best.

IV. Whilst keeping all the ideas in mind to which we have directed you, avoid too artificial an arrangement of questions.

V. It is generally best, especially in difficult or legal cases, to get several interviews with the patient or criminal, rather than prolong your examination too much.

VI. It may sometimes be well to watch the suspect, without allowing him or her to see you.

VII. Do not be too hasty in assuming that all the information derived from others is correct.

VIII. Found your opinion chiefly on matters observed by yourself.

Certificates in Lunacy.

"As a general rule two certificates are required with every insane person who is to be placed in an asylum or licensed house, each of which must be signed by a *registered* physician, surgeon, or apothecary, in *actual practice.* Each certificate must state that the patient is a proper person to be taken charge of and detained, and the person signing the same must specify the facts upon which he has formed his opinion that the patient is a lunatic, idiot, or person of unsound mind, and must distinguish facts observed by himself from facts communicated to him by others. It must not be founded only upon facts communicated by others, nor must there be any want of certainty in stating the facts required to be specified. The two medical men who sign the certificates must not be partners, nor must one be an assistant o the other, nor may either of them be a commissioner or visitor [in unacy]; nor, if the patient is to be received into a licensed house or a ospital, may either certificate be signed by any one who, or whose ather, brother, son, partner, or assistant, is wholly or partly the prorietor of, or a regular professional attendant in, such house or hospital, r has signed the order for the reception of the patient; nor may any erson receiving any percentage on, or otherwise interested in, the paynents to be made by or on account of the patient, or keeping a licensed ouse, or attending in his medical capacity a licensed house, asylum, hospital, or place where any lunatic may be confined, sign a certificate for the reception of a private patient into any licensed or other house; nor may any one who, or whose father, brother, son, partner, or assistant, shall sign the order for the reception of a patient into an asylum sign the certificate for the reception of the same patient. Medical men signing certificates contrary to any of these provisions are liable to heavy penalties. *Each medical man must, separately from the others, have personally examined the person to whom the certificate signed by him relates not more than seven days previously to the reception of such person into the house or hospital.* If he be not satisfied with his own personal examination he is bound to make further enquiries before signing the certificate. The certificate need not be dated on the day of examination. Any person falsely stating or certifying anything in such certificate, and any person not being a physician, surgeon, or apothecary, signing as such, is guilty of a misdemeanour. A medical man, moreover, signing any such certificate which is untrue, without taking due care and making due inquiries, is liable to an action by the person injured by the consequences which may ensue. He is only liable, however, where he has wilfully signed a false certificate, or where he has been guilty of gross negligence in conducting the examination. If the certificate be signed maliciously, and without reasonable or probable cause, it may also be treated as a libel."

[The principal Acts relating to lunacy are 1 & 2 Vict., c. 14 (1838); 3 & 4 Vict., c. 54 (1840); 8 & 9 Vict., c. 100 (1845); 16 & 17 Vict., c. 70 (1853); 16 & 17 Vict., c. 96 (1853); 16 & 17 Vict., c. 97 (1853); 18 & 19 Vict., c. 105 (1855); 23 & 24 Vict., c. 75 (1860); 25 & 26 Vict., c. 86 (1862); 25 and 26 Vict.. c. 111 (1862).*] † Besides the Commissioners in Lunacy (office, 19 Whitehall Place, London, S.W.), there are two Medical Visitors of Lunatics appointed from time to time by the Lord Chancellor. Every candidate must be a physician in actual practice, and must not have been, within the two preceding years, interested in any house licensed for the reception of lunatics. The salary is £1500 per annum. They are debarred from practice during their tenure of appointment. Travelling and incidental expenses are allowed, and the Lord Chancellor may order a superannuation allowance to any visitor who has served for twenty years, and is above sixty years of age, or who is disabled by permanent infirmity.

Under section 10, c. 96 (16 & 17 Vict.), *No person can be received into any registered hospital or licensed house, or as a single patient, under any certificate which purports to be founded only upon facts communicated by others.* A medical certificate may be amended if incorrect or defective. *No medical man can receive, as a boarder in his house, any insane person, whether for medical treatment, or otherwise, unless he has previously obtained a licence from the Commissioners of Lunacy, and one certificate duly signed by two other medical men.*

In January, 1861, a medical man was convicted of misdemeanour for thus illegally receiving a patient (*Reg.* v. *Kelly*, C.C.C., January 29, 1861.) He pleaded ignorance of the law. This was not a legal defence. ("Med. Times and Gaz.," Jan. 28, 1861, p. 105; "Lancet," Feb. 9, 1861, p. 151.)

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* Lunatic Asylums in Ireland, 38 & 39 Vict. c. 67 (1875).

† "Abstract of the Principal Laws affecting the Medical Profession." By R. G. Glenn, LL.B., Barrister-at-Law. (Churchill's "Medical Directory.")

There seems to be an idea in the minds of medical men that they are allowed to take idiots, epileptics, or other feeble-minded patients, without a licence. This is not so. If the mind be unsound, you are no more warranted in taking the patient into your house without a licence than you would be in keeping a large establishment for the insane. In any doubtful case it would be better to lay the exact facts before the Commissioners of Lunacy, or to seek the advice of one or more experts. The seventy-fourth section of cap. 97 provides that in cases of emergency a person (not a pauper) may, under special circumstances (these being stated in the order), be received into a house or hospital upon a certificate signed by only *one* medical practitioner, provided that within *three days* two other such certificates are signed by two other medical practitioners not being connected with such house or hospital, upon a like examination. If the keeper of the house or hospital detain a person upon *one* medical certificate only beyond a period of *three* days without such further certificates, it is a misdemeanour in such keeper of house or hospital.

A pauper lunatic, however [s. 67, cap. 97] does not require the certificate of more than *one* medical practitioner, provided the person has been previously examined by a justice of the peace, clergyman, and overseer, or relieving officer. The certificates of Irish medical practitioners are valid for the confinement of lunatics in England, and conversely those of English practitioners are valid for asylums in Ireland. A special Act has been passed for Scotland (20 & 21 Vict., c. 71); and, by section 34 & 35, the rules regarding the certificates are similar to those of the English statute. But Scottish asylum keepers do not recognise certificates signed in England. Whether this be the law, or whether it be founded on a misunderstanding of the statutes, we know this to be the fact. The form of the certificate in the case of private patients [not being paupers] is as follows:

"I, the undersigned, being a (duly registered) physician [*or* surgeon, *or* apothecary; *here set forth the qualification*], and being in actual practice as such, hereby certify that I, on the   day of   , at [*here insert the street, and number of the house* (*if any*), *or other like particulars*], in the county of   , &c., separately from any other medical practitioner, personally examined A. B. [*here insert the patient's names*], the person named in the accompanying statement or order, and that the said [*here insert the names again*] is a lunatic [*or* an idiot, *or* a person of unsound mind], and a proper person to be taken charge of and detained under care and treatment, and that I have formed this opinion upon the following grounds, viz.:—

"1. Facts indicating insanity, observed by myself. [*Here state the facts.*]

"2. Other facts (if any) indicating insanity, communicated to me by others. [*Here state the information, and from whom.*]

(Signed)   "Name.
"Place of abode.

"Dated this   day of   , one thousand eight hundred and   ."

For the sake of convenience, the order for reception (signed by the father, husband, mother, wife, brother, sister, or other relative, or guardian or friend, who undertakes the responsibility of payment, &c.)

and the blank form for the second medical certificate (precisely similar to the one just given) are generally printed upon the same paper. Except under circumstances of great emergency (where the single certificate is to suffice for three days), the certificates should be written on these printed forms.

The form for pauper lunatics is very similar, there being forms and spaces for the Magistrate's order, &c.

N.B. Remember—

(1) To state your medical *qualification*, that is, your diploma [s], and whence obtained.

(2) Put the *address* of the patient as well as your own. Mr. Justice Coleridge pronounced the certificate of an alleged lunatic (*re Greenwood*) which came before him on a *habeas* for the discharge of said alleged lunatic, informal, and therefore he set it aside (Feb. 1855) because the late Serjeant Wilkins took objection that the number of the house and name of the street where the examination took place were not inserted.

(3) Comply with the rules as to *dates*. In *Hall* v. *Semple* the certificate was informal, and the Commissioners ordered him to be discharged, because Hall was admitted into an asylum on July 31st by certificate dated on the 29th, but the visit and examination were made on June 13th, whereas the Act only allows *seven days*. (Queen's Bench, Westminster, Dec. 1862.) Hall recovered £150 damages from one of the medical men who had certified, because this physician had confided too much in the statements of the wife, and other interested persons. Hall was a very bad-tempered man, but it was not found that he was really insane.

(4) Remember that your certificate may some day become the subject of legal investigation. Even in the case of a penniless pauper, some one or other may be found to champion his cause. And it is not enough for you to act *bonâ fide*, and to be right in your motives. The certificate you give should be such as you would not be ashamed to defend in any court of law.

Dr. Millar, in his "Hints on Insanity," remarks that some medical men fill up certificates with *vague and irrelevant facts*, such as—

(1) "Obstinate; has the manner and appearance of an insane person; complained of her head; refused her food, and would not go downstairs; melancholy."

(2) "His countenance is expressive of great anxiety and restlessness; his pulse exceedingly feeble—he appears to have been bled; he says all the public-houses in London belong to him; also that he is going to marry the Queen."

(3) "She is suspicious of her husband without cause; says he keeps bad company; she is most irritable and jealous, and takes stimulating drinks to a dangerous and exciting extent."

(4) "His unreasonable and inconsistent conversation."

(5) "That, being a married woman, recently confined of her first child, she persists that she is not married,* and is under delusions that she has committed some great sin; she is melancholy, seldom speaking when spoken to, and almost totally refusing her food, and constantly attempting to beat herself, requiring to be kept under restraint."

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* It turned out, afterwards, that this woman was really not married.

(6) "She is very good-tempered, but, day and night, she talks almost incessantly, occasionally sings; she says she comes from Otaheite, and relates stories of those around her doing absurd things."

(7) "The patient has old bronchitis, and is very weak; her memory is almost lost; she believes her mother is still alive, and gives me messages to persons long since dead; at times she is noisy and excitable, and is generally very loquacious."

But Dr. Millar quotes worse still, from certificates which could not be received, and were therefore sent back to be amended, because *these facts offer no evidence of insanity.*

(8) "Refuses to take her medicine, and resists in every way; closes her teeth, and threatens to strike any one near her; obliged to use the strait-waistcoat."

(9) "Violent in her temper, and very abusive."

(10) "He is very bad-tempered, and imagines he is coming into some property."

(11) "He has a suspicious, dangerous, suicidal eye; he evinces, in his appearance, cerebral mischief."

(12) "Moody, irritable temperament, and of weak memory in many particulars."

(13) "She has an insane appearance, and wanders about, apparently without object; she is anasarcous."

(14) "General conduct for the last three months; sleeping on the coffin of his wife three months ago; general obstinacy and delusions of various kinds; extreme excitement at times; this day he appears much more rational and quiet."

(15) "Great excitability from religious delusions."

(16) "He imagines he has no other clothes to put on beside his present habiliments; he imagines he is about to come into some property."

On the other hand, the following are cited by Dr. Millar, and Dr. Taylor also, as "*good facts*":—

(17) "That she is in a state of restlessness and excitement, and generally incoherent in her conversation and conduct. Thus, stating her place of abode to be twenty-five miles from Hertford, when it is only two miles; that her doctor resides in Fore-street, Cripplegate, and goes to Hertford to see her every day, when, in fact, he resides in Hertford, and only sees her now and then; that her uncle farms 3000 acres of land in one farm, besides several others, when, in fact, he only farms 150 acres; and that all her conduct is without rational sequence of ideas, passing rapidly from one thing to another; that, whilst I was conversing with her, she began to undress herself, apparently without purpose."

(18) "From desperate attempts at self-destruction; from groundless fears of poverty."

(19) "She states that she is a lost person, and without hope of forgiveness; that she will be taken to prison, and die a miserable death; that the devil whispers in her ear that she has committed the unpardonable sin."

(20) *Of an old Man aged eighty-three.* "Mental and moral incapacity,

and perverted feeling and views with regard to women and female children; personal habits uncleanly and slothful."

(21) "He states that he is a Prince of France; that he possesses a palace, and has recently had two fortunes left him—one of £400,000, the other of £600,000; that he is going to Liverpool, a distance of 160 miles, with a horse and cart, that will take him four hours to go, and eight to return."

(22) "Violent excitement, with rapid, incoherent, and obscene speech."

(23) "From his being subject to epileptic attacks, followed by incoherence, and, occasionally, [by] uncontrollable violence."

(24) "A general restlessness and perturbed manner. When asked to sit down, he says, 'I can't sit down!'; to put out his tongue, 'I can't put out my tongue!"; if he eats his food? he replies 'he can't eat food; he can't swallow; that he has no throat; that he never eats anything; that his feet are broken, and his hips are broken—that he is altogether broken.' He lies in bed, and when asked to get up, he says, 'I can't get up!' All of which sayings are delusions, and not true. He does get up, and he does sit down; and he does eat, drink, and sleep; and his feet are not broken; nor has he received any injury to his ribs or hips."

It is greatly to be regretted that some medical men have rendered themselves ridiculous by assigning as symptoms of insanity such things as "keeping a cockatoo," "revoking at whist," "a great desire to excel as a musician," "inability to repeat the multiplication-table," "not knowing how much money is in his pocket," and the like. No mere loss of memory, no want of book-learning, or of accomplishments, make a man insane; and a man or woman may be very eccentric, without being *non compos mentis* in the eyes of the law. Mere bad temper, again, is not insanity in a legal sense. In *Hall* v. *Semple* it was proved that the quarrelsome husband of an equally quarrelsome wife had been confined as a lunatic, at the instigation of the wife, and that for some years she had been unsuccessfully endeavouring to obtain certificates of his insanity from medical men, who had very properly refused to sign them. In this case the judge remarked, "A man might detest and hate his wife very much, and be guilty of brutal conduct towards her, and yet not be insane." And again: "A delusion, of course, does not mean a mere mistake of fact. Hundreds of people may have notions that their friends have injured them, or their wives deceived them, not founded on fact; and yet these are not delusions, as we now use the word. By delusions, we understand ideas fixed in the mind, without anything to lead any rational being to entertain them. These delusions often accompany insanity, and so are taken to be *indicia* of insanity; and in this case, no doubt, it is extremely important, when so much stress is laid on delusions, to make up our minds first whether they had any real foundation in fact. Now, I should very much doubt the case of the defendant, if it rested on his examination of the plaintiff alone. It was a very short one, and he himself said it led him to no certain conclusions; and what took place at it is doubtful, as the plaintiff and defendent gave contradictory evidence about it. It is agreed that he was not there above ten minutes. You will consider what took place on this occasion; but what strikes me is, that at the end of it the defendant states he was not satisfied, and had not made up his mind. It would be culpable negligence on his part if he did not make due inquiries."

In reference to the important question of medical responsibility, the following observations were made by the same judge:—"The true ground of complaint is the negligence of the defendant, and the want of due care in the discharge of the duty thrown upon him; and I think that if a person assumes the duty of a medical man under this statute, and signs a certificate of insanity, which is untrue, without making the proper examination or inquiries which the circumstances of the case would require from a medical man using proper care and skill in such a matter; if he states that which is untrue, and damage ensues to the party thereby, he is liable to an action; and it is to that I desire to draw your particular attention. In point of law, if a medical man assumes under this statute the duty of signing such a certificate, without making, and by reason of not making a due and proper examination, and such inquiries as are necessary, and which a medical man under such circumstances ought to make, and is called on to make, not in the exercise of the extremest possible care, but in the exercise of ordinary care, so that he is guilty of culpable negligence, and damage ensues, then an action will lie, although there has been no spiteful or improper motive, and although the certificate is not false to his knowledge."

On Feigned Insanity, and on some Difficulties in the Diagnosis of Unsoundness of Mind.

We have before remarked that insanity is often feigned, in order to escape punishment. Occasionally (as in the case of David amongst the Philistines) it may be assumed for political purposes. Mania, melancholia, monomania, and some kinds of dementia, are the forms most likely to be assumed. Epileptic fits are also often simulated. Impostors, for the most part, overdo their part. They make too absurd replies; and they often mingle together the features characteristic of different forms and different stages of insanity. Either they refuse to answer all questions, or they answer too much at random, and wildly. Thus it would rouse suspicions for a supposed lunatic to reply to the question of "What is your name?" by the answer, "Twenty-two miles;" or, if asked how many children she had, to answer, "Twenty thousand."

Real lunatics may ramble from one thing to another, mix up dates, and jumble the false together with the real; but they seldom interchange numbers with names, or colours with the value of money. Those who feign insanity may often be detected by watching them when they think they are alone, and by putting them off their guard. We have before objected to the employment of violent measures, as often useless, almost always unnecessary, and unsuited to the use of educated gentlemen, who are members of a humane profession. The methods which are useful in private practice for the discovery of mental disease are to be used in criminal cases. The illustrative cases will show how difficult it sometimes is when insanity really exists to discover the particular delusions which monomaniacs cherish. Two examples, often quoted before, are so apposite, that we think they will bear to be cited again. The late lord Erskine was engaged on a case, in which the lunatic had indicted a most affectionate brother, together with the keeper of the madhouse, for false imprisonment. He was placed in the witness-box; and the learned lord, not instructed in the delusion of the monomaniac, consumed the whole day in fruitless attempts to expose the hallucination. At length Dr. Sims came into court, and suggested to the learned counsel that the patient believed himself to be the Lord and Saviour of mankind. Lord Erskine then directly addressed him in that character, lamenting the indecency of his ignorant examination. The patient at once expressed his forgiveness, and with the utmost gravity and emphasis, in the face of the whole court, said, "I am the Christ!"

In a similar case, tried before Lord Mansfield, the patient evaded the questions of the court the whole day, till his physician arriving, asked him what had become of the princess with whom he corresponded in cherry juice? Instantly the man forgot himself, and said it was true he had been confined in a castle, where, for want of pen and ink, he had written his letters in cherry juice, and thrown them into the stream below, and that the princess had received them in a boat. Such answers, of course, immediately terminated these cases.

If it be thus difficult to determine the existence of insanity when it really exists, it is almost obvious that it is likely to be still more difficult to detect feigned insanity, except by continuous observations. But rather than condemn the innocent, or allow the guilty to go unpunished, you should, if necessary, ask for extension of time, when your opinion is requested in a difficult case. Far better that a trial should be postponed for a few weeks, or even for a few months, than that you should commit an injustice, or give a hasty opinion, which you may afterwards bitterly regret. The works of Laurent and Tardieu, previously quoted, with the systematic treatises of Esquirol, Bucknill and Tuke, Conolly, Winslow, Blandford, Combe, Brierre de Boismont, Delasiauve, Griesinger, and others, quoted in the "Bibliography," will all afford you valuable assistance in this direction. The following Table may give you some useful hints :—

TRUE INSANITY.	FEIGNED INSANITY.
1. Almost always *hereditary.*	1. Evidence of hereditary transmission wanting or weak.
2. Usually preceded by well-marked premonitory symptoms, or	2. Comes on suddenly without warning —or with very slight premonitory symptoms.
3. If sudden, has an adequate or sufficient cause, such as accident, sudden loss of fortune, bodily disease, losses of blood, &c.	3. Has no sufficient determining cause, unless the fear of punishment be so regarded.
4. Usually adheres to certain types (as described, pp. 836 to 853),*	4. The symptoms are incongruous—not typical—symptoms of acute mania being mixed with idiocy, for example.
5. The real lunatic is often ignorant of his condition, and imagines himself sane, or apologises for his condition when conscious of it.	5. The impostor nearly always strives hard to convince you of his insanity, and seems to glory in it.
6. The criminal lunatic seldom seeks to escape. He is usually somewhat sobered by the crime—if he be conscious of it he often affirms that	6. The impostor who has committed a crime tries to escape—when caught, he tries to seem more mad than before, and generally denies the

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* You must not, however, expect all cases of true insanity to conform strictly to rule or to the description of nosologists. Nature is not to be thus cramped. Nor will any given case be likely to exhibit all the features of its type.

TRUE INSANITY.	FEIGNED INSANITY
he was impelled to do it, that he could not help it, &c.	crime, or justifies it by logical reasons as self-defence.
7. When deaf and dumb this is usually congenital or acquired before the crime.	7. Deaf-dumbness and loss of sight, &c., are said to come on *suddenly* after the crime.
8. True lunatics generally change their behaviour but little in the presence of medical men, or of other spectators.	8. Impostors generally over-act their part, and seem *more mad* when they think they are watched.
9. They are generally indifferent to danger, or to the consequences of their actions.	9. The impostor is generally careful not to hurt himself, and is keenly alive to the danger of imprudent admissions.
10. Almost every form of insanity has its characteristic *facial expression*, gait, and accompanying complications (paralysis, convulsions, constipation, incontinence, &c., &c.).	10. Except the impostor be a fine actor who has carefully studied his part from the life (*i.e.*, from real cases), this expression, gait, &c., will be wanting—so will the complications.

No doubt this Table might be extended considerably, but we fear not profitably. A very slight experience of true insanity will soon convince you that no very hard and fast lines can be laid down on these subjects. Whilst deprecating violent means, we must own that the use of threats, the exhibition of surgical instruments, and the electric shock from some form of battery, have often proved useful in unmasking those who pretended to be deaf and dumb.

On the Responsibility of Criminals in a Medico-Legal Sense, especially as regards Insanity and Allied Conditions.

Deaf mutes were formerly classed with idiots, and therefore presumed not to be responsible for their actions, nor admissible as witnesses for or against others. This is very properly no longer the case. We know that many deaf mutes (the majority of whom are born so) are possessed of very fair intelligence ; and they can, therefore, when able to converse by signs, the "Manual Alphabet," and the like, be admitted as witnesses (unless blind also), and are held to be responsible, unless they are shown to be imbecile, or otherwise of unsound mind. In *Regina* v. *Goodman* (Stafford Summer Assizes, 1841), a deaf mute was sentenced to imprisonment for theft ; in *Regina* v. *Brook* (Bucks Summer Assizes, 1842), the deaf and dumb prisoner was charged with feloniously cutting and stabbing. The proceedings were reported to him in writing. Baron Alderson sentenced him to a year's imprisonment. In *Regina* v. *Jackson* (Bedford Summer Assizes, 1844), Baron Alderson held that before the evidence of a deaf and dumb witness could be received, the court must be satisfied that he understands the obligation of an oath. But this is clearly treating him as sane. Dr. Taylor reports [probably from Archbold] one case, in which a deaf and dumb woman was charged with cutting off the head of her child. She pleaded not guilty by signs, but she could not be made to understand the rest of the proceedings. She was therefore discharged, and afterwards confined as a criminal lunatic.

The deaf and dumb can, therefore, legally contract marriage, when it can be shown that they understand the meaning of the contract.

In *Harrod* v. *Harrod* (Vice-Chancellor's Court, June, 1854), it was attempted to prove that the plaintiff was illegitimate, on the ground that his mother, who was a deaf mute, and of more than ordinarily dull intellect, was an imbecile, and therefore unable to contract marriage. Sir W. P. Wood said there was an important difference between "unsoundness of mind," and "dulness of intellect." The presumption in such cases is always in favour of sanity; and the fact of a person being deaf and dumb did not raise a presumption the other way.

Mere *paralysis*, or the existence of *neuroses*, such as *epilepsy*, *hysteria*, and the like, are also not to be assumed as in themselves evidences of insanity. It is true that repeated epileptic attacks blunt the intellectual powers; but this is not to be assumed. It will usually be sufficiently evident. We have before said that *drunkenness, per se*, does not affect legal responsibility for crime. It is also necessary to insist strongly that *paralysis, per se*, is not insanity, because one form of *hemiplegia* (generally that in which the right arm and leg, &c. are paralysed) is very often associated with *aphasia*, or inability to formulate the thoughts in articulate and intelligent speech. The patient then becomes in many instances either just like a mute, being unable to speak at all, or, like a foreigner, only able to say a few words, "Yes," "No," and a few more, in his own, or any other language. That this does not necessarily exclude intelligence is shown by the fact that many aphasics can write down what they mean, and make themselves intelligible by signs. In *Moberly* v. *Mitchell* [Probate Court, December, 1875], this subject was discussed. Sir Wm. Jenner and Dr. F. Braine were examined on this point. The latter stated (correctly) that "Anybody suffering from aphasia might call a thing by the wrong name; and supposing he required a book, might ask for a teapot. At the time he knew he was making a mistake, and this would make him irritable." The case ultimately turned on other issues. Of course, *the intellect often is impaired in these cases of paralysis with aphasia; but this is not to be assumed without other evidence.*

Professor Jaccond ["Clinical Lectures at the Lariboisière Hospital," Paris; "Medical Times and Gazette," Sept. 30, 1876] distinguishes five kinds of aphasia, which may be classed under three principal headings, namely:—

I. Disorder of formation or verbal ideation.	1. Hebetude. 2. Verbal amnesia.
II. Disorder of voluntary transmission.	3. Logoplegia.
III. Disorder of expression or articulation.	4. Glosso-ataxy. 5. Glossoplegia.

Only hebetude, or extreme degrees of the other forms, combined with inability to write intelligently, or to convey the requisite ideas by other modes (such as signs), would necessarily invalidate the sufferer from making a will, which would be good in law. The safest rule, however, is to disregard the paralytic condition, *per se*, and to test the intelligence in other ways, noting the general conduct and behaviour, and the effect of speaking to and reading to the patient.

Acts committed in the delirium of disease or accident, if criminal, would fall into the same category as the acts of lunatics. In the case of suicide, this is generally met by the verdict of temporary insanity in the coroner's court. *Suicide*, although a criminal act, is not held to be a legal proof of insanity.

We are now coming to one of the most difficult parts of our subject. We cannot conceal our conviction that legal opinion and practice, as regards the responsibility of criminals for their acts, are not in accord with the teachings of medical science Nor can we deny that medical witnesses themselves are greatly to blame for this discrepancy. Instead of a clear statement of the facts of the case, and a clear expression of scientific opinion, they have often jumbled together facts and opinions, and treated the courts either to exhibitions of metaphysical subtleties, equally foreign to law and common sense, or to still more painful exhibitions of their own ignorance. The plea of insanity, too, has very often been raised on the most trivial grounds by counsel, in order to appeal to the sympathies of jurymen, some of whom may have insane friends and relatives. We would not blame an advocate for doing his best to screen the criminal for whom he pleads. We do, however, blame the members of our own profession for appearing as partisans, whether in civil or criminal cases; and we wish you clearly to understand that you are not justified, as scientific or skilled witnesses, in pronouncing any man insane in a criminal case, unless you could equally assert his insanity, were the issues of the trial entirely indifferent to him. *The evidence for the insanity of a criminal* (apart from those rare cases in which the crime itself, or the manner of its execution, afford almost conclusive evidence of insanity) *should be similar, if not identical, in character with that required for rendering certificates of insanity valid in non-criminal cases.* In other words, *as medical witnesses*, dismiss from your minds entirely, the nature of the penalties to which the prisoner is liable, except so far as they may make you anxious in the interests of justice to the supposed criminal, not to overlook any discoverable proofs of his irresponsibility.

Before commenting further on the subject, we will take the interpretation of the law as it stands by our judges.

Mr. Justice Brett (trial of George Blomfield for murder of James Catt, in dockyard at Chatham [Midsummer Assizes, 1875; *vide* "Lancet," July 31, 1875] said: "The man may be mad. I assume that he is so in the medical sense of the term; but the question here is, whether he is so mad as to be absolved from the consequences of what he has done? He is not so absolved, though he is mad, if he be not so mad as not to know what he was doing, or not to know that he was doing wrong." In the trial of Hadfield, in 1800, for shooting at King George III., in Drury Lane Theatre, Lord Kenyon, with the concurrence of the rest of the judges of King's Bench, interrupted the defence, and said, that "With regard to the law, as it had been laid down, there could be no doubt whatever. If a man be in a deranged state of mind at the time of committing an act, he is not criminally answerable; the material part of the case is, whether at the very time his mind was sane." [Here the distinction between right and wrong is, we think, very properly, lost sight of.] Lord Kenyon held that, as (it had been proved that) the prisoner was deranged immediately before the offence was committed, it was improbable that he had recovered his senses in the interim; *and although, were they to run into nicety, proof might be demanded of his insanity at the precise moment when the crime* *was committed*, yet there being no reason for believing him to have been at that period a rational and accountable being, he ought to be acquitted; and the jury accordingly acquitted him." ["Collinson on Lunacy," vol. i., p. 458, quoted by Beck.] In the case of Bellingham, tried at the Old Bailey, for the murder of Mr. Perceval, May 15, 1812, Chief Justice Mansfield is reported to have told the jury that they must be satisfied, in order to acquit, that the prisoner was incapable of judging between right and wrong, and that at the time of committing the atrocious act with which he stood charged, he did not consider that murder was a crime against the laws of *God and Nature.* Two months after (trial of Bowler for shooting Mr. Burrows) Mr. Justice Le Blanc left it to the jury to determine whether the prisoner, when he committed the offence, was capable of distinguishing between right and wrong, or whether he was under any illusion in respect to the person he shot, which rendered his mind at the time insensible to the nature of the act he was about to commit, since in that case he would not be legally responsible for his conduct. Lord Lyndhurst (in *Rex* v. *Offord*, Bury Assizes, 1831, where prisoner was tried for murder, by shooting with a gun) told the jury that they must be satisfied before they could acquit the prisoner, on the ground of insanity, that he did not know when he committed the act what the effect of it, if fatal, would be. With reference to the crime of murder, the question was, did he know that he was committing an offence against the laws of *God and Nature?*' Lord Erskine, in his speech, on the trial of Hadfield, said that to absolve from criminal responsibility, there must first be *delusion*, and, secondly, *the delusion and the act must be connected.* In the recent case of McNaughten, who shot Mr. Drummond in mistake for another person, under the influence of the monomania of persecution [January 7, 1843], and was tried in the Midsummer Assizes, 1843, Chief Justice Tindall, in his charge, strongly and clearly laid down the distinction of right and wrong. Fifteen judges returned answers to queries submitted to them by the House of Lords in consequence of McNaughten's trial; and the bench, with the exception of Mr. Justice Maule, were unanimous in affirming—

"(1) *That notwithstanding the party committed a wrong act while labouring under the idea that he was redressing a supposed grievance or injury, or under the impression of obtaining some public or private benefit, he was liable to punishment.*

"(2) *The jury ought in all cases to be told that every man should be considered of sane mind, until the contrary was clearly proved in evidence.**

"That before a plea of insanity should be allowed, undoubted evidence ought to be adduced, *that the accused was of diseased mind*, and that at the time he *committed the act he was not conscious of right and wrong.* This opinion related to every case in which a party was charged with an illegal act, and a plea of insanity was set up. *Every person was supposed to know what the law was, and therefore nothing could justify a wrong act, except it was clearly proved that the party did not know right from wrong.* If that was not satisfactorily proved, the accused was liable to punishment; and it was the duty of the judge so to tell the

* This seems founded in natural equity.

jury, when summing up the evidence, accompanied by those remarks and observations which the nature and peculiarities of each case might suggest and require." In answer to Question III., "In what terms ought the question to be left to the jury as to the prisoner's state of mind at the time when the act was committed?" they gave no answer. In reply to Question IV., "Whether delusions excused offences?" their answer was, "*If the delusion were only partial, the party accused was equally liable with a person of sane mind. If the accused killed another in self-defence, he would be entitled to an acquittal; but if the crime were committed for a supposed injury, he would then be liable to the punishment awarded by the laws to his crime.*" The judges were further questioned as to the propriety of examining experts (who never saw the prisoner previous to his trial), and asking them as to their opinion on the state of the prisoner's mind—and here the opinions were not quite unanimous—but most thought that interrogatories could only be put after the facts were proved. Mr. Justice Maule dissented from this view. [These questions and answers, *in extenso*, are contained in Dr. Guy's "Principles of Forensic Medicine," p. 207, note.]

If we analyse these opinions they come to this, that the majority of our judges consider a man with a fractional intelligence is to be treated precisely (as regards the acts committed by him) as if his intellectual powers were in their integrity, or, to put the matter in a more familiar form, that a lunatic, who may have less than half his intellectual powers in a healthy state, is to be punished for the acts he commits precisely as if he had the use of the whole of his brain, unless the witnesses, and especially the medical witnesses, are prepared to state that at a particular moment he did not know right from wrong. In the case of *George Victor Townley*, Derby Winter Assizes, 1863, arraigned for the murder, by stabbing, of Miss Goodwin, a young lady to whom he was to have been married, Baron Martin said, commenting on the medical evidence [which was somewhat weak in regard to actual delusions on the part of the prisoner, although evidence of insanity in his grandmother's family was adduced], "I shall tell the jury that although there might have been disease of the mind to some extent, yet if the prisoner knew that the act he was committing would probably cause death, and that the doing of it would subject him to legal punishment, there was criminal responsibility." *Counsel for the prisoner.*—"Many men have been acquitted with approval who must have been convicted under such a direction." *Baron* MARTIN.—"I have drawn that up from a summing-up of Justice Le Blanc, which has been much approved of, and from a decision of Lord Denman, and another of Lord Lyndhurst, and I believe it to be a correct statement of the law. I have put aside from my consideration the ruling of the judge who tried *Bellingham*, because that has been objected to." The jury returned a verdict of wilful murder. And as regards this particular case we think not unjustly. The prisoner was subsequently examined by Commissioners in Lunacy, and by various medical men, respited, sent to Bethlehem Hospital, afterwards sentenced to penal servitude for life—removed to a convict prison, where he subsequently committed suicide. Dr. Taylor (*loc. cit.*, p. 583-589) gives this case in considerable detail, and Baron Martin's charge almost *in extenso* as relates to this point, with a number of references, of which the most important are *Reg.* v. *Johnstone* ("Med. Gaz.," vol. 37, p. 421), *Reg.* v. *Overston* ("Journal of Psychological Med.," 1848, p. 193), *Reg.* v. *Brough*

[Guildford Summer Assizes, 1854] ("Jour. Psych. Med.," 1854, p. 609), *Reg.* v. *Clarke* (Norfolk Lent Assizes, 1851), *Reg.* v. *Monkhouse* (C. C. Court, Dec., 1849), *Reg.* v. *Arnold* (Aylesbury Lent Assizes, 1850), *Reg.* v. *Butters* (Shrewsbury Summer Assizes, 1853), and the following works: —"Mayo's Clinical Facts," 1847, p. 193; "Croonian Lectures," "Med. Times and Gazette," 1853; "Lettsomian Lectures by Dr. Forbes Winslow," "Lancet," June, 1853, "Med. Gazette," (vol. 37, p. 421). Other papers in "Journal of Psychological Medicine;" Mr. F. Stephen ("Judicial Papers," vol. 1, p. 67), and "Criminal Law of England, 1853," by the same; Bucknill on "Unsoundness of Mind in Relation to Criminal Acts," 1854; an Essay by Mr. Knaggs of same date on "Unsoundness of Mind in reference to Responsibility." See also the references given by us under Epileptic Mania, p. 846. Dr. Taylor justly remarks that the phrases "right and wrong," as laid down by some judges, are objectionable, since they assume that what is legal is right, and *vice versâ;* and that the worst feature of our law is its uncertainty. It also, as he says, completely ignores that *uncontrollable impulse* to kill which is the very essence of autophonic or homicidal mania.

Whilst thus thinking the present state of the law unsound in a scientific point of view, we are fully alive to the fact that this proceeds partly from the defective state of medical science on many of these questions—partly from the inherent difficulties of the subject—and from the tendency of counsel and of medical witnesses to raise the defence of insanity in the case of almost every criminal whose means will permit him to pay for the opinions of experts. The question has been very fully and fairly discussed by Dr. Guy in his "Forensic Medicine," pp. 195 to 223.

The following statements and conclusions of Dr. Guy deserve quotation. We have inserted some qualifying remarks in brackets so,— [ ] :—

1. *In mania consciousness, memory, and reason may remain intact, even in the midst of the most violent paroxysms.*

2. In insanity the senses are deceived and confounded [see remarks on this at page 858].

3. The persons with whom the madman associates derive their character [in his eyes] from his delusion.

4. Real impressions on the organs of sense become, as in dreams, the materials of imaginary scenes.

5. The strange antics of the madman are the effects of his delusion.

6. The acts of the madman, the result of his delusions, are [often] such as no sane man would believe fitted to compass the object in view.

7. The violence of the madman is often the effect not of mere passion but of his delusions.

8. The maniac, if of a reserved disposition, or when impelled by a strong motive, can [and often does] conceal his delusion [see remarks at pages 867 and 868].

9. The acts of the maniac often evince the same forethought and preparation as those of the insane [see case at p. 201 of Dr. Guy's work].

10. The maniac, in spite of his proverbial cunning, is easily imposed upon. [Our literature, even in novels and serials, is full of instances of preservation of life by ready wit in the sane, and of presence of mind acting as a defence against lunatics.]

11. *Maniacs in confinement* [and otherwise] *are often conscious of their* [mental] *state, and know the legal relations in which it places them.* Dr.

Guy quotes the following :—When Martin set fire to York Minster the inmates of a neighbouring asylum eagerly discussed how and whether he would be punished. One, who seemed as mad as the rest, said—" They cannot hang him, because he is mad—he is *one of ourselves !* "

Dr. Guy also insists, very properly, that a great number of lunatics know that the acts they do are wrong, only they cannot help doing them. He therefore submits [p. 214] that all legal and moral tests in the case of lunatics who are subject to delusions, completely fail, and that our law ought to be assimilated to that of France—" Il n'y a ni crime ni delit lorsque le prévenu était en état de démence au temps de l'action." In this we most thoroughly agree.

Summary.

In all cases of crime committed by supposed lunatics be very careful, cautious, and slow, in forming your opinion. When there is much doubt it is better to state the facts as you find them, and not to give any opinion unless the facts fully justify it. There should be clear evidence in the following points :—

(1) Of hereditary tendencies.
(2) Of sufficient predisposing causes, such as severe accident or disease, loss of fortune, over-work, and the like.
(3) Of weakness of the intellectual powers, delusions, or of epileptic fits, and previous insane acts.
(4) The conformation of the cranium, and the state of the general health, as well as the habits of the accused, should be carefully inquired into.
(5) The *procès-verbal*, or depositions, should be carefully studied as to the nature of the crime, its mode of perpetration, its suddenness, the existence, or otherwise, of provocation and possible motives—the time, place, &c., and the behaviour of the criminal afterwards, when first arrested—or on giving himself into custody. These hints will be best understood from examples. *See* Illustrative Cases.

On the Physical Basis of Insanity, and on the Morbid Changes found in the Brain and in other organs.

Under the heading of Idiocy and Cretinism (page 849), we have given some of the physical characters of the cranium, and other bodily organs of those very deficient in intellect. Whilst in the descriptions of mania, general paralysis, &c., other physical conditions have been noted. Many of the text books give pictures of the facial expressions of many typical forms of unsound mind [Bucknill, Guy, Taylor]. These are generally drawn from rather extreme cases [glaring instances], but in minor degrees the same characters are presented by the features of all who have either been long insane, or suffer from severe forms. Some monomaniacs, however, present no very special physigonomy. Although the *hysterical* diathesis is well marked, *epilepsy* requires to be of some long standing, and the fits to be frequent, before the "facies epileptica" becomes recognisable.

I. Still it may be said in general terms that *the great majority of persons* *of unsound mind have a peculiar physiognomy.* The principal differences presented are: (1) Either unusual smoothness of the features, due to paralysis of the facial muscles, and degenerative changes—giving a want of expression and feeble look to the face*—this is often combined with (2) Tremulous movements of the lips, tongue, and other muscles—and convulsive movements of the lower jaw, &c. (3) In mania, monomania, melancholia, &c., we often get the facial lines unusually marked (or a direct contrast to Nos. (1) and (2)). Opposing muscles are in action at one and the same time, as the occipito-frontalis and corrugators, &c. (4) The staring, glaring, fixed or rolling, and fierce or dull expression of the eyes of the insane is a matter of common observation. (5) There may be special paralysis of single muscles or groups of muscles of the head and face. The two sides of the face, or the two halves of the head, may be unsymmetrical, or unequally developed. (6) No one, however, of these characters by itself, nor any combination of them, is pathognomonic of insanity.

II. Other parts of the body besides the head may exhibit deformities, or changes due to paralysis or other neuroses, or to other diseases. It is sufficient to mention the changes of the muscles in general paralysis, the rickets and bronchocele in cretinism, &c., to explain our meaning.

One general disease is exceedingly common in the insane. We refer to tuberculosis, especially in the form of pulmonary phthisis. This is often overlooked in life. There appear to be some peculiarities in regard to the symptomatology of consumption in those mentally afflicted, which render the diagnosis difficult. Thus it would appear that the temperature in such cases is often lower than in sane persons, suffering from the same disease. Even the stethoscopic signs appear to be less clearly marked.† The tubercles may, in some cases, be in the nervous centres, in the abdominal organs, &c.

Valvular and other diseases of the heart, including dilatation, hypertrophy, and degenerations, are also pretty common.

So are diseased bones. We have already mentioned rickets. The medico-legal relations of insanity would be very incompletely described if we did not mention the remarkable fact that the *bones of chronic lunatics are often extremely brittle*, and therefore easily broken by slight violence. Drs. Ormerod and S. W. D. Williams investigated this subject some years ago, and found that their experiments justified them in concluding that *nearly half the chronic insane have bones more or less diseased.*

In many cases the animal matter exceeds the mineral [contrary to the rule in health]. *The ribs are specially prone to this brittleness, and could often be easily crushed between the finger and thumb!* [St. Bartholomew's Hospital Reports, vol. vi. "Lancet," Sept. 3, 1870, and Sept. 30, 1876. "Journal of Mental Science," vol. xix., p. 160.] It is important to remember this, when asylum attendants and others are charged with brutal conduct towards the insane, who are found with broken bones. *Do not, however, assume this in fatal cases, but examine the bones themselves.* We must also bear in mind that though the brittleness adds to the ease with which the bones may be fractured, it does not, *per se*,

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* Sir James Paget has shown that changes in the spinal cord and other parts of the nervous system give a peculiar smoothness to the skin of the fingers and other parts.

† See Papers by Dr. Clouston in the "Journal of Mental Science," April 1863, and July 1864.

exclude violence. When a man has nearly all his ribs broken, it may be assumed that he has either been very roughly treated, or that he has himself inflicted the injuries by falls or otherwise [*see* Wounds, &c., in the next chapter].

Diseases of the genito-urinary organs are very common in the insane, *e.g.*, Bright's disease, uterine and ovarian disorders in females, disease of the bladder and urinary passages, and of the testicles in males.*

The *liver and alimentary canal* are often diseased in those of unsound mind. This is especially true of melancholia, and of forms of insanity with depression.

Painful affections of the lower bowel and anus [piles, fissures, ulcers, strictures, both simple and malignant], have a peculiarly depressing influence on the mind. We have known a man's character completely altered by the *cure* of a fistula in ano.

Cancer† and semi-malignant tumours, and intestinal worms, by the pain and annoyance they inflict, may aid in the genesis of insanity.

Anæmia is very common, especially amongst female lunatics—in puerperal mania, &c. Hæmatomata or blood tumours (especially in the ears), erysipelas, gangrene [of the skin, limbs, *lungs*, &c.], and bedsores, are all common towards the closing scenes of chronic forms of insanity.

Eczema and psoriasis are moderately common. It has been noted [we think first by Dr. Brown-Séquard] *that very peculiar and erratic forms of skin disease often accompany or precede neuroses and insanity.*

Syphilis undoubtedly plays a large part in the production of conditions of mental unsoundness.

As regards the *pulse, respirations, and temperature* of the insane, no general rules can be very safely laid down. We may admit that except in acute mania, and in the presence of complications, *the temperature is generally lower* in the insane than in those of sound mind—but we shall find many exceptions. The *respirations* will often be quicker, owing to tubercular deposit, or long complication, or the violent exertions of maniacs, but this is by no means invariable, whilst *the pulse* is very variable. In acute mania and conditions of excitement, it is quicker than in health. The presence of tubercles also will often have the same effect.‡

The bowels are usually constipated. The skin has an unpleasant odour, in a large number of the insane. They often bear such large doses of narcotics, emetics, and purgatives, as few sane persons could safely take. They can dispense with sleep for many days, go without food for a long time, often seem indifferent to pain, bear a strong light with impunity, and in other ways differ from healthy persons.

III. The most important deviations from health in the insane are found in the cranium, and more especially in the brain. We have already alluded to premature ossification of the skull, and to a want of symmetry in the two sides of the head and brain, and to congenital absence of parts [*see* especially under Idiocy, page 850].§ Very little importance is now attached to the mere size of the head or absolute weight of the brain. We have already seen that we may have a very large or a very small head, even amongst idiots. Hydrocephalus may cause the head to enlarge in adult life or old age, as in the case of Dean Swift. Foville has shown that insanity and brain diseases are epecially common in Gascony and Normandy, where children's heads are artificially compressed into an elongated pointed cylindrical form. Esquirol confirms this.*

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* *Sugar, albumen, phosphates*, oxalates, uric acid and urates; and cholesterin, and other biliary products, are often found in the urine, as may be supposed, but we need not say do not prove insanity!

† Cancer is, however, said to be very rare. Only six cases in 384 autopsies in the Vienna Asylum [Griesinger], or less than 2 per cent.

‡ See remarks by Dr. Guy in a note to his Manual, p. 218.

§ See Dr. Mitchell's remarks on the use of the forceps under Idiocy (page 848).

1. *The cranial bones are often thickened.* Greding found in 216 autopsies, 167 instances of thickening, 38 of abnormal thinness of these bones. There are exostoses, spiculæ, &c., in some cases, especially syphilitic ones.

2. The *dura mater*, and *other membranes, are often greatly thickened.* What is called pachymeningitis is particularly common in the intemperate. The arachnoid is very often opaque. All the membranes are hyperæmic.

3. The *blood vessels* of the membranes, and of the brain itself, are abnormal (from disease) in a vast number of the insane. Hoffmann thinks inequality of the jugular foramina from contraction very common in the insane.

Atheroma, calcareous changes, deposit of lymph outside vessels, plugging inside them (embolism), and great thickening of the connective tissue of the smaller arteries and arterioles are exceedingly common changes, especially in general paralysis and chronic forms of mania, dementia, &c. The blood vessels of both the brain and its membranes may be partially empty, or filled with a pale watery blood (Anæmia of brain and membranes). Or the gorged vessels relieve themselves, either by rupture, producing extravasations and apoplectic clots [the remains of which are often found], or by exudation of serum, giving the brain a sodden aspect, making the membranes, &c., œdematous, and distending the ventricles. The lumen of the cerebral vessels, or, in other words, their calibre, is generally lessened by the morbid changes.

4. The convolutions are often wasted or atrophied; there are inflammatory softenings in the grey matter. The whole cerebral substance may be softened to a pulp. Sometimes the white substance of the brain is not only softened, but presents a sieve-like, or cribriform aspect from perforations and erosions. Or the brain substance (and this is very common) is harder than it should be, from increase of its connective tissue. Sclerosis is the name given to this condition. It often occurs in patches or placques (insular sclerosis), as Charcot pointed out. In most of these cases there are muscular tremors.

5. The cells of the grey matter may have undergone degeneration, or disappeared altogether, whilst the white tubes or fibres are converted into mere fibrous cords.

6. There may be either *increased* brain-weight or diminished ditto. *Parchappe* ["Mem. de l'Acad. de Médecine," 1840, p. 142, and "Comptes Rendus," 31 Juill., 1848] seems to think the brain is generally *less* heavy in insanity, especially in chronic cases. Whilst Boyd ["Brit. Med. Journal," Sept. 30, 1876, page 425] seems from an examination of 2050 brains of the sane and insane to draw a different conclusion. We take the following Table, only altering its arrangement, from him:—

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* Meningeal apoplexies or hæmorrhages are very common.

Weight in Ounces.

Organ.	Sane Males.	Insane Males.	Sane Females.	Insane Females.
Cerebrum	41·4	41·8	36·4	37·5
Cerebellum	5·1	5·4	4·6	4·7
Pons and Medulla	1	1	·9	1·
All together	47·5	48·2	41·9	43·2

But in the insane dying from nervous diseases he confirms Parchappe as to there being slight wasting. He finds the left brain is usually the heavier one. Male brains weigh more than the females (as a rule) both in the sane and insane [·016 in the insane]. [See "Philosophical Transactions," for 1861, and "Med. Chirurg. Trans.," vol. xxxix.] The weight of the encephalon was greatest in mania, $54\frac{1}{16}$ oz., less in melancholia, $51\frac{11}{16}$ oz., still less in dementia, $50\frac{5}{16}$ oz., least of all in general paralysis, $49\frac{12}{16}$ oz.

Dr. Boyd's table of average weights of sane brains is quoted in Aitker's "Science and Pract. of Med.," 3rd ed., p. 259, vol. ii. We do not reproduce it, as the differences of weight in the sane and insane are not sufficiently great to warrant our making them tests. At 30 to 40 years of age he gives 48·2 oz. for the encephalon, and 5·15 for the cerebellum=53·35 oz. for males, and 43·09 and 4·74=47·83 oz. for females at the same age. The *specific gravity* of the brain is said by Skae and Sankey to be generally *increased* in those of unsound mind. Dr. Bucknill states the reverse. He gives 1·036 as the sp. gr. of average *healthy* brain. Dr. Sankey 1·041 for white matter, 1·034 for grey in health. Dr. Aitken gives the following:—Central ganglia 1·040 to 1·047; cerebrum 1·030 to 1·048; cerebellum 1·038 to 1·049. All these results are very closely approximate. *The amount of blood in the brain causes discrepancy* in fatal cases of insanity. Our methods of taking the specific gravity are also somewhat imperfect. Solutions of common salt are generally employed.*

We may get gummous, hydatid, cancerous, and other tumours in the brain. Also abscesses; but, of course, all these may exist without insanity.† Griesinger's conclusion may be quoted here in an abbreviated form [see *loc. cit.*, p. 432, &c.].

I. In Acute Insanity.

(1) The brain may be found apparently quite healthy, as far as our present knowledge extends. It is to be noted that the *microscopic* changes now often found have only recently attracted attention. Yet skilled observers have failed to find disease in some cases of very recent insanity.

(2) Anæmia with serous infiltrations, or hyperæmia, especially of grey matter, is common.

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* Healthy brain matter will sink slowly in good beer or in milk of good quality.

† The optic discs, retinæ, and other parts of the eye will sometimes disclose neuritis, optic atrophy, and other ocular changes when the eye is examined with the ophthalmoscope in cases of brain-disease. These changes, however, do not imply insanity, although they may coëxist with it.

(3) The membranes are often thickened.
(4) There is no constant *anatomical* distinction between mania and melancholia.
(5) The brain is more often found healthy in melancholia than in mania. Yet in melancholia it is very often anæmic.
(6) There is *usually* some anatomical change in mania.

II. Chronic Insanity.

(1) There is *nearly always* some anatomical lesion—hyperæmia, and thickening of the membranes, are common.
(2) So are atrophy of the brain, especially of the convolutions, chronic hydrocephalus, effusion into the sub-arachnoid space, pigmentation of the cortical substance, extensive andp rofound sclerosis [conditions not found in acute cases].
(3) There may be softening, but more often pigmentation of the superficial layers, superficial induration, and adhesion of the pia mater in various degrees.
(4) The ventricular walls become inflamed, granular, and adherent in many cases.
(5) Hyperæmia is rare in chronic cases, unless it be *hyperæmia ex vacuo*; sometimes the more or less atrophied brain is anæmic and œdematous.
(6) In profound mental weakness (dementia) there is generally considerable atrophy of the brain.

III. Paralytic Dementia.

(1) Sometimes no naked eye changes, but always microscopic ones. It is rare for coarse changes to be absent.
(2) Great œdema of membranes, adhesion of pia mater, greyish-red softening, coloration, partial or superficial induration of cortical substance, increase of connective tissue, destruction of true nervous matter (cells and tubes), are the common changes.
(3) The brain is generally much wasted (atrophied), the convolutions flattened, indistinct. There is great increase of connective tissue in the white matter.
(4) Pachymeningitis, meningeal apoplexy, degeneration of cerebral arteries, are all common.
(5) The spinal cord becomes involved in many cases, by extension of the degeneration of brain cells, increase of connective tissue, &c. [Rokitansky, Joffe, Mildner, Lockhart Clarke, &c.] The authors have often seen this.
(6) No other form of insanity shows such constant lesions. They are not, however, always the same in all cases, but varied.

Conclusions. A. Insanity may exist without any appreciable abnormality. This may be due to peripheral causes, or to our imperfect methods of examination.

B. In the vast majority of cases, however, there are anatomical lesions in the brain, or in its membranes, or in both.

C. Sometimes these spread to the spinal cord.

D. Other diseases (especially tuberculosis) often complicate insanity.

The following figures may help the comprehension of part of this chapter, and of the section on injuries to the head in the next chapter :—

Fig. 108 shows the *base of the brain* (turned uppermost), *with the cranial nerves.* If we begin in front, on the left side of the figure, we get (1) the *anterior lobe* of the cerebrum ; (2) the *middle lobe ;* (3) is part of the *posterior lobe* of the cerebrum. The shaded part, marked (4), is the *cerebellum ;* (5) is part of the inferior vermiform process of that organ. Immediately above *this is the medulla oblongata* (19), in the middle line. Above this is (14) the *pons varolii*, or *mœsencephalon ;* (8), in front, shows the two *olfactory* bulbs, springing from three roots : these give off the nerves of smell ; the figure (7) shows where the *corpus callosum* would be found by slightly separating the anterior lobes ; (10) lies just in front, and (11), just behind the *optic commissure*, or X like body, giving off the *nerves of sight* (*optic* or *second pair*) ; (12) the *corpora albicantia* or *mammillaria*, which are really the anterior crura of the *fornix.* Close here is the *pituitary body ;* (13) shows the *third* (*pair*) *of nerves* (motores oculorum), supplying the upper eyelids, pupils, and several muscles of the eyeballs ; (14) *pons* (see before) ; (16) shows in front the *fourth nerve* (patheticus), supplied to the superior oblique muscle of the eyeball ; and behind this the *fifth*, or *trifacial* (trigennial) *nerve*, which supplies the face, &c., with sensation, is supplied to the tongue, teeth, nose, muscles of mastication, &c. [one of the most important nerves in the body, and resembling a spinal nerve] ; (17) the *sixth pair* (abducentes) *of nerves*, supplied to external rectus of eyeball, which rolls eye outwards ; (15) is the *seventh nerve* (portio dura), supplying the facial muscles of expression, &c., and the gustatory, or nerve of taste, to the tongue in part, and the *portio mollis*, or nerve of hearing (auditory) ; (20) is the *eighth nerve* (pneumogastric, glosso-pharyngeal, and spinal accessory), supplied to palate, throat, windpipe, gullet, lungs, heart, stomach, liver, and sundry muscles (*trapezius*, &c.) ; (21) is the *hypoglossal*, or ninth nerve, supplying the muscles of the tongue ; (6) is one of the *tonsils* of the cerebellum, not to be confounded with the tonsils of the throat.

FIG. 108.

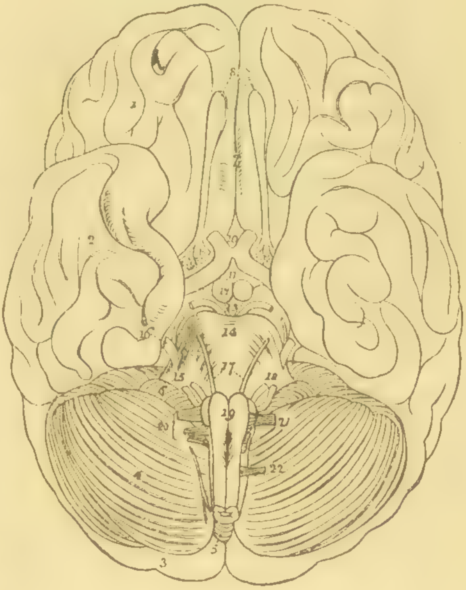
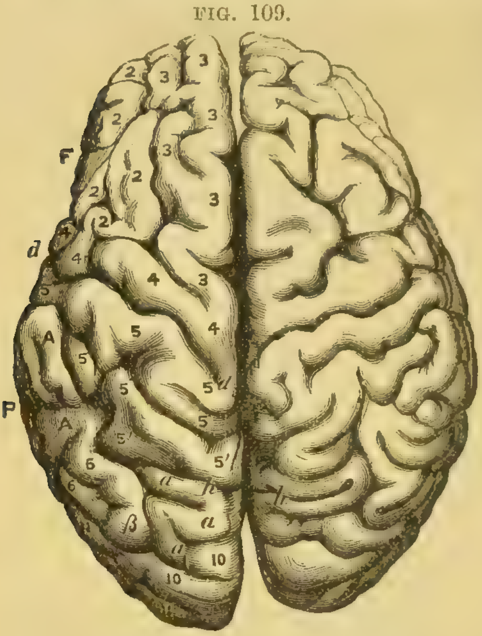


Fig. 109 shows the upper surface of the convolutions of the brain, or cerebrum, showing the two symmetrical *halves* into which it is divided. F shows the *anterior* or *frontal* convolutions ; P the middle, or parietal ones ; *d*, *d* shows the fissure of *Rolando :* the numbers refer to the convolutions. We have a *side* view of the convolutions, with similar numbering and lettering, in fig. 110.

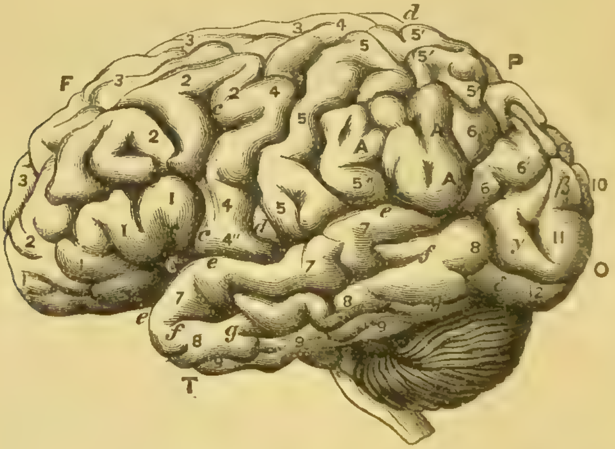
F and P denote frontal and parietal convolutions, as before; O means occipital ditto. The cerebellum and medulla oblongata are seen below, *under* the figures 9 and 12; *c*, *c* mark the *fissure* or *furrow of Rolando*; *e*, *e* mark the *fissure of Sylvius*; T is the *inferior marginal convolution.* Between the convolutions 7, 7 and 8, 8 is the *parallel fissure.* The O, which is *white,* just above *e* 7, shows the *insula,* or rather *lobe of the insula.*

FIG. 109.



The convolution marked I in our figures is often called the *third frontal or superior marginal convolution.* This (posterior part of anterior, and anterior part of middle lobe), especially in its posterior third, is often called *Broca's region.* This, with the parts about the *insula,* is supposed to be the special region of articulate speech. It is the part generally affected in *aphasia.* We must remember that *aphasia is most common with hemiplegia on the right side.* The clot, or embolism, or other lesion, is to be found on the opposite or left side of the brain in a large majority of the cases; but the recent lectures delivered by Dr. Brown-Séquard at the College of Physicians warn us not to be too dogmatic in attempting to localize cerebral injuries from the symptoms in life.

FIG. 110.



The Facial Angle—Estimation of Cranial Capacity.

The mere size of the brain is of small importance compared with the proportion of the various parts one to another, and the integrity of each part in itself. It is true on the one hand that men distinguished for their mental powers [Göthe, Cuvier, Sir Walter Scott, &c.], have often had large and heavy brains; the average in such cases [according to Dr. Davis, "Proc. Roy. Soc.," Jan. 23, 1868] being 54·6 ozs., whilst in individual instances as much as 60 ozs. have been reached. Yet on the other hand a man may have a large brain, and still more, a large head, without being either a genius or even possessing average mental powers; whilst there are many men to whom Goldsmith's lines may be applicable—

> " While still the wonder grew
> That one small head could carry all he knew."

In relation to insanity, the remark previously made as to idiocy applies to nearly all the varieties of mental unsoundness—that both large and small heads may be found amongst the mentally afflicted. Some remarks have been made at p. 660 on the capacity of the cranium, in different races, as tested by millet seeds. In judging, however, of this point in the living subject, it is clear that other methods must be adopted. The *calipers* are often used for this purpose. The "Transactions of the Anthropological Society," the "Comptes Rendus," and the works on anthropology previously referred to, page 660, all contain numerous measurements of the skull in different races. For practical purposes, the Authors recommend the following method:—Measure from the root of the nose to the junction of the head with the neck (*antero-posterior measure*); take the circumference of the head at the most prominent part of the forehead (*circumference*); take the measurement across the top of the head from ear to ear (*transverse measurement*). The *facial angle* has fallen into some disrepute, probably because its importance was over-rated. Without entering into the question of priority of discovery, we may state that it was first brought into notoriety by P. Camper.* This angle is the intersection of a line drawn through the centre of the meatus auditorius externus towards the floor of the nostril, with a perpendicular let fall from the most prominent part of the forehead. Some draw the first line level with the inter-maxillary bone. It can be most simply determined (as Colin suggests) by a pair of compasses with the legs extended so as to correspond with the lines mentioned. The angle can then be easily traced on paper, and subsequently measured by a protractor or otherwise. The angle is thus given by Cuvier:—

Man.		Other Animals.	
European Infant	90°	Young Orang Outang . . .	67°
" Adult	85°	Old ditto	40°
Decrepid ditto	75°	Dogs	35° to 40°
Adult Negro	70°	Fox	24°
Female Bosjesman . . .	71°	Brown Bear	32°

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* "Dissertation Physique sur les différences réelles que présentent les traits du Visage," &c. Par P. Camper. Utrecht, 1791, p. 34, &c. See also Carpenter's "Physiology," pp. 24 and 25; Colins' "Traité de Physiologie Comparée des Animaux Domestiques," tom. i., p. 168; Cuvier's "Anatomie Comparée," 2d édit., tom. ii., p. 164; Ward's "Osteology," p. 142, &c., 1st edition; Durer, A., "De Symmetriâ Partium in Rectis Formis Humanorum Corporum," 1553.

Colin gives the following for domestic animals [*see* the original for others]:—

Horse (4 years old)	14°
Very old horse (English)	13°
Donkey	16°
Bull (adult)	20°
Dromedary	15°
Goat	25°
Newfoundland Dog	36°
Pig	13°
Rabbit	29°
Domestic Cat	41°

For other modes of estimating the capacity of the cranium, such as *Daubenton's angle* (founded on the position of the *foramen magnum*), the measurement of the face compared with the skull, and the like, we must refer to the sources named in the foot note. All these methods rather refer to original capacity than to the present condition of the person examined. The facial angle alone would often lead to erroneous conclusions, as Dr. Down and the Authors have repeatedly found it to measure nearly 90° in idiots.

Capacity for Making a Will.

There is little difference between the inquiry as to soundness of mind and the capacity to make a will. The testator, or will-maker, must be sane at the time he makes it. He is, therefore, temporarily incapacited by drunkenness, delirium, the stupor induced by narcotics, and similar conditions. The case of the late Mr. Bravo shows that a valid will may be made by a man who is suffering from the action of a powerful poison. One of the Authors was lately consulted on the question whether a man suffering from typhoid fever was capable of making a will. In the special case referred to, there was no delirium in the day-time; the question was, therefore, answered in the affirmative. This case has not, so far as we know, been argued before any Court. But in *Maxwell* v. *Maxwell* [Probate Court, July, 1872], *gastric fever*, by which enteric fever was possibly meant, was held by the Court an insufficient ground of objection. As Dr. Taylor says, "*Integritas Mentis* non corporis sanitatis *exigenda est*," is the rule of the Courts. Thus in *Harwood* v. *Baker*, *not erysipelas and fever, but the stupor and drowsiness induced by them*, were held by the Privy Council [in 1841] *as invalidating the will.* In the case of *Blewitt* [March, 1833], *paralysis* was the alleged ground of incompetency. But in *Penfold* v. *Crawford* [C. P., 1843], though the testator had suffered from *apoplexy and loss of speech*, yet it was shown that his mental powers were good, and a deed made subsequently was held to be valid. A similar case, occurring last year, has already been referred to at page 870. In *Whyddon* v. *Billinghurst* [Prerogative Court, July, 1850], the testatrix executed a will in an attack of cholera. It was set aside because it could not be proved that her mental powers were unaffected by her condition. The Authors, however, know from the experience of 1866 that persons who are pulseless and speechless from the collapse of cholera, may be perfectly sensible, and on recovering will repeat what has been said under the supposition that they could neither hear nor understand what was said of them.

In Day's case (June, 1838), *epilepsy* was alleged to have affected the mind. Of course it often does so. Esquirol's opinion on hemiplegia (agreeing with that given above) may be found in the "Annales d'Hygiène" [for 1832, vol. i., p. 203]. The case of the Duchess of Manchester is briefly given in the illustrative cases.

The Making of Wills.

Medical men are sometimes asked to make wills for their patients. They should never do so when it is possible for a respectable solicitor, notary, or even an intelligent friend to be called in for the purpose. Yet it is well for medical men to know the law on this subject. We may briefly summarize it as follows :—

1. A will should be in *writing.* It will not do to sign a printed form. It is, of course, best for it to be on parchment, and written in ink, but paper and even pencil may be made use of on an emergency. In the remarkable case of Lord St. Leonard's will, the original document being lost or stolen, the evidence of witnesses, and principally of his daughter (Miss Sugden), was taken as to its nature and contents, and this verbal will was acted upon by order of the Court.

2. Every will must be signed at its foot or end by the testator, or by some other person in his presence, at his dictation, and by his direction. Whatever is written *below* this signature is of no force as a will. The testator may make a mark if unable from any cause to write.

3. The separate sheets, if there are more than one, should be at least *initialled* by the testator and witnesses.

4. Two at least, or more witnesses, must sign at the same time, in the presence of the testator. They should be in such a position that he [or she] can see them, and they see him [or her].

5. No legacy to *witnesses* is valid. A legacy may, however, be left in a separate codicil.

6. An executor may witness. If he do so, however, he cannot inherit, except as mentioned under last paragraph.

7. All *alterations* must be attested by initialling or otherwise.

8. So must all codicils.

9. In drawing up a will, those who are not members of the legal profession should use the plainest language they can, and carefully avoid all ambiguous terms. It is better to repeat names and descriptions than to permit any doubt as to the meaning of a pronoun or other word used to indicate those who are to benefit.

10. The will should be read over to the testator, if drawn up by another, before he affixes his signature.

11. His hand should not be guided. It is better for him [or her] to sign in a shaky hand, than to allow it to be said he or she was forced to sign.

12. Medical men cannot be too careful, for their own reputation, and for that of the profession, to give no occasion to relatives or friends to say that they have exercised undue influence over their patients in order to secure for themselves the property of those whom they have attended in a medical capacity. Our courts of law look with just

suspicion on all wills which leave very large sums, or the bulk of a testator's property, to a medical attendant to the prejudice and injury of lawful heirs. It is, no doubt, often just and proper that grateful recognition of medical skill and kindness should be made, but it is by no means desirable that the public should be allowed to think that medical men abuse the great influence their peculiar position gives them for their own personal aggrandisement.

Of the Capacity of Lunatics and Persons in Advanced Stages of Disease for Marriage.

Mutatis mutandis, what have we said about wills, applies to marriage. The law considers insanity a civil impediment to matrimony, because there must be in lunacy an absence of that rational consent which is necessary to the validity of a contract. *The marriage of a lunatic is therefore void, ab initio.* If it be alleged that the parties were married during a lucid interval, strict proof of such lucidity would be required. For this reason the marriage of a lunatic was dissolved at his own request, when he recovered, in the case of *Turner* v. *Myers* ["Med. Gazette," vol. viii., p. 481]. See also the case of *Baldry* v. *Ellis* [Norwich Summer Assizes, 1851]. A lunatic's estate may, however, be taxed to supply a wife with necessaries, because this is fulfilling a rational contract made whilst he was sane. [*Reed* v. *Legard* (Court of Exchequer, May 30, 1851); and *Seaton* v. *Adcock* ("Journal Psych. Med.," 1851, p. 297).] See also the illustrative cases. Beck states, in a note to p. 425, *loc. cit.*, "that in the State of Ohio the having carnal intercourse with an insane woman, not the offender's wife, he being over eighteen years of age, is an offence punishable by confinement in the penitentiary, from three to ten years." ["American Quarterly Review," vol. x. p. 41.] No special provision is made by our law for such cases. Doubtless, both judges and juries would consider the insanity of the female assailed as an aggravation of a criminal assault, or an act of adultery. In the case of *Mordaunt* v. *Mordaunt*, *the wife's insanity after marriage was held to be a sufficient ground for dissolving the tie*—an entirely novel, and, in our opinion, unjust decision, which at present is unique. See illustrative cases.

Marriages contracted *in extremis*, in other words, *in articulo mortis*, are justly looked upon with suspicion by our courts. Provided, however, it can be shown that the dying man or woman was in perfect possession of his or her senses, and was not overawed by force, such marriages are, we believe, considered as valid. Rochefort, best known as the editor of "La Lanterne," was married to his former mistress on her death-bed, he being taken from prison for the purpose. This marriage was legal in France, and would have been so in England. Although these late marriages may be equitable in some cases, it is doubtful, in our minds, if their legality is founded in justice, when one of the parties is incapable from physical weakness of fulfilling the conditions implied in a marriage. It might, however, be argued, that medical skill is not infallible, and that it is possible for recovery to take place in the most desperate cases; and that, therefore, if both parties are willing, no impediments should be thrown in their way.

On other Civil Contracts made by Lunatics.

Our law regards marriage as a civil contract. As regards other engagements (bonds, cheques, promises to pay, leases, agreements to sell on mortgage, and other contracts), their validity will depend very much (as Dr. Taylor remarks) on the circumstances which accompany the act. "If there be nothing unreasonable in the conduct of the lunatic, and the party with whom he contracts has no suspicion or knowledge of his insanity, then the contract will be binding on the lunatic and his representatives. It was so held in *Monckton* v. *Cameroux* (Exchequer, June, 1848."*) The contract must, however, be a reasonable one in itself, and suitable to the circumstances of the contractor. Thus in a case [known to the Authors] heard before judges in chambers, the defendant, who was the medical superintendent of a lunatic asylum, was sued for a wine-bill. It appears that he was [temporarily] attacked with an expansive delirium, like that of general paralysis, and, during this state, gave orders for £3000 or £4000 worth of a particular sherry. His whole income from all sources was under £2000, and the judges therefore held that this was an unreasonable order, *primâ facie*, as it was stated that the wine was for his own use. Both as regards contracts and wills, it is often difficult tò distinguish between *eccentricity* and *insanity*. This difficult question is in this country frequently referred to a common jury for their decision.†

Illustrative Cases.

CASE I.—*Mr. Edward Davies' Case.*

[Abridged from Beck (*loc. cit.*, p. 420, &c.). *See* also "Quarterly Review," vol. xlii., p. 354; "Lancet," vol. vi., N.S., p. 214.]

Mr. Davies was of low birth, and imperfectly educated. At school he was thought shy rather than stupid. As a tea-dealer he amassed wealth, and displayed great industry, but he was habitually nervous and anxious, so that the night before the great tea-sales at the India House he could not sleep. He was dyspeptic and hypochondriacal. He read a great deal, and was fond of reciting aloud ("spouting"). He would gesticulate whilst reciting Byron and Shakespeare. His mother treated him as a child when he was twenty-seven, never allowing him any control over his time or his money. She prevented him from seeing persons of the female sex. He began to be impatient of this ceaseless vigilance and control, offered her money to go away, and consulted Mr. Laurence, Dr. Burrows, Dr. Latham, and other medical men, who thought him suffering from monomania, especially as he often used threats against his mother and those who thought him insane. He was soon after confined in a private mad-house. An application was made for his release. Several physicians examined him (Sir George Tuthill, Drs. Munro, Macmichael, and Sutherland), and the majority being of opinion that he was insane, a commission was appointed by the Chancellor. The testimony adduced was chiefly what has already been stated. His feelings against his mother, and his having purchased property at an extravagant rate, were alleged against him. He expressed much indignation at his confinement, but was calm and correct in his conversation. It appeared that at the very time that he was just about to be confined, he not only gave sensible directions as to his business, but was consulted by the very persons who put him in the asylum as to the management of the business. The result of the commission was his restoration to his liberty and property. As Dr. Gooch remarked, Davies always was, and probably always would be, a person of weak mind ; but he had sufficient capacity for making money, was inoffensive in his habits, although eccentric, and had absolutely no known delusion, unless we consider his antipathy to his mother's conduct as such. As Dr. Coombe says, "*The true standard is the patient's own natural character*, and not that of the physician or the philosopher."

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* Dr. Taylor refers also to *Staniland* v. *Willett*, Vice Chancellor's Court, Nov. 1848; and *Donat* v. *Haniquet* (Guildhall, 1854); also to *Reed* v. *Legard* (Exchequer, May 30, 1851), as to the responsibility of a lunatic for necessaries supplied to his wife; and *Seaton* v. *Adcock* ("Journ. Psych. Med.," 1851, p. 297).

† At p. 895, it is stated that there are some 90,000 lunatics in the British Islands. The actual numbers for England and Wales, as reported by the Lunacy Commissioners, are as follows:—On the 1st of January, 1876, there were in asylums and workhouses 64,916 persons. During the year 1875, 4,909 were discharged as "recovered;" and 4,592 were reported as having died. These numbers added together, make 74,417.

CASE II.—*Supposed Dementia, or Imbecility.*

[Quoted from Tardieu ("Etude Medico-légale sur la Folie," pp. 241—251].

On the 28th of August, 1863, the Civil Tribunal of the Department of the Seine issued a commission to try the sanity of Mdlle. Stephanie de S. C. It was alleged that from infancy almost she had been incoherent, and her conduct outrageous and extraordinary. She was said to grow worse as she grew older. In 1858, she was reported to have been violent, and from this time showed no regard or respect for her mother, whom she abused in no measured terms, and had even struck upon one occasion. Her mother had sent her, in March, 1859, to a convent school. There she so pestered her mother by letters that after fifteen days she was taken home again. It was said that she had threatened her mother, her teachers, servants, and even a priest, aged eighty. Those who flattered her could do anything they liked with her. For one servant who thus behaved, she stole wine ; and she sought to be always in his company. On his dismissal, she refused to eat or sit at table. In her fury she smashed her watch, jewellery, a lamp, &c., &c. Finally she left her mother, and took a lodging in a low street, hired for her by the dismissed servant. It would appear that she contracted a *liaison* with a designing person, and was probably pregnant by him when she left her mother's house. Dr. Lasègue and other medical men who examined her, testified, however, that her answers to questions were perfectly rational. She accused her mother (apparently with justice) of many of the faults with which she herself was charged. We give specimens of her letters. She writes to the curé :—

"You would have done far better had you persuaded my mother to send away her servant, and not her daughter. Had she done so, I should not have been the talk of tap-rooms! My character would not have been quite destroyed. I might indeed have been married respectably."

And to her mother:—

"Mamma, I am greatly astonished at the way in which you treat me. What have I done that I should be forbidden to set my foot inside my own mother's house? Do you wish to kill me with grief?

"I may have done many wrong things. My head is a very poor one, but I am not mad."

And again:—

"Miss de C. says the people have been gossiping about me in the village, ever since I left. Do you really wish that my reputation and my whole future should be ruined in this manner?

"If you really believe all you have said I cannot be your daughter!

"Will not you send Mrs. M. to call for me next Saturday, to assist at the village feast, in giving away the prizes for the little girls? This would silence scandalous tongues, and is as much to the interest and credit of all the family as it is to my own."

She was placed for a while in a private asylum, but manifested no signs of insanity there. She then eloped (as has been stated) and was again placed under restraint. Then came the Inquiry by Commission, the result of which was, that however blamable in a moral point of view she might be, and however *weak*-minded, she was neither imbecile nor demented, therefore not of unsound mind in a legal point of view.

CASE III.—*Miss Bagster's Case.*

[Beck, *loc. cit.* page 423.]

Miss Bagster was a young lady of fortune, who perpetrated (*sic*) a runaway match with Mr. Newton. An application was made by her family to dissolve the marriage, on the ground that she was of unsound mind. The facts urged against her before the Commissioners were, that she had been a violent, self-willed, and passionate child; that this continued as she grew up; that she was totally ignorant of arithmetic, and therefore incapable of managing her property; that she had evinced a great fondness for matrimony, having engaged herself to several persons; and that in many respects, she evinced little of the delicacy becoming her sex. Dr. Sutherland (four visits) came to the conclusion that she was incapable of taking care of herself or of her property. She had memory, but neither judgment nor reasoning power. Dr. Gordon did not consider her capacity to exceed that of a child of seven years of age. Several non-medical witnesses who had known her from infancy spoke of her extremely passionate and occasionally indelicate conduct. On her examination before the Commissioners her answers were pertinent and given in a proper manner. No indelicate remark escaped from her. Drs. Morrison and Haslam were not disposed to consider her imbecile or idiotic. She confessed her ignorance of arithmetic, but said that her grandfather sent excuses when she was at school, and begged that she might not be pressed. The jury brought in a verdict that Miss Bagster had been of unsound mind since November 1st, 1830 (the trial was in 1832), and the marriage was consequently dissolved. "London Medical Gazette," vol. x., pp. 519, 553, and London "Atlas" newspaper, July 8 and 15, 1832. This verdict seems to the authors to have been unreasonable. Dr. Morrison very justly said, that he would undertake, in six months, to teach her arithmetic, and the use of money. "A deficiency of education," he said, "would account for all the appearances observed in Miss Bagster."

CASE IV.—*The Earl of Portsmouth's Case.*

[Beck. Note to page 423.]

In the suit for the dissolution of the marriage of the Earl of Portsmouth, on the ground that he was of *weak*, and afterwards of *unsound* mind, it was proved that his servants were his playfellows, that he was fond of driving carts loaded with dung or hay, that he was occasionally extremely cruel to his horses and his domestics, breaking the leg of his coachman, who was lying with it already broken. He had a great desire to bleed persons, carrying lancets with him; would follow funerals, &c.! The Commission found him of unsound mind, and the marriage was subsequently dissolved. Haggard's "Ecclesiastical Reports," vol. i., p. 355.

As regards *cruelty*, not to refer to Nero, or to the tyrant of Syracuse in ancient times, or to the police reports of the present day, the reader may consult with advantage the "Merkwürdige Criminal-Rechtsfälle" of Dr. P. J. A. Ritter von Feuerbach, 2ter theil [Giessen, 1839] art. *Andreas Bichel*, the girl slayer, and art. *Georg Rede*. It is extremely likely that the *were-wolves* and *vampires* of the middle ages were lunatics with the mania of cruelty.

CASE V.—*Mr. W. F. Windham's Case.*

[December, 1861, Taylor, *loc. cit.*, pp. 543—547.]

The question raised here was similar to that in Miss Bagster's case. Fifteen relatives petitioned for an inquiry into the state of Mr. Windham's mind, on the ground that he laboured under congenital deficiency of intellect. On the other side it was argued in his favour that his mental condition, if below the normal standard, was entirely owing to the results of a neglected education. The inquiry lasted thirty-three days, and 140 witnesses were examined, fifty for the petitioners, and ninety for Mr. Windham. The evidence was very conflicting. His whole life and conduct were inquired into. He had been sent to Eton, but learnt little there. As a boy he was wholly unlike other boys; and when he attained his majority, in 1861, his conduct was extravagant and wild. But he was not entirely deficient in business matters; for it was proved that his uncle, one of the petitioners, had shortly before negociated with him for the sale of a piece of land of the value of £1000, thereby admitting his capacity to transact business. It was said that he was very extravagant, buying things he did not want at exorbitant prices, thus incurring large debts, with no reasonable prospect of being able to pay them. That he was guilty of gross indecency of language and conduct in public places; and that even in the presence of ladies he appeared to have no sense of shame; that he habitually associated with low characters of both sexes; and three weeks after he became of age, he married the paramour of one of his associates; having infected her with syphilis, he gave her from £12,000 to £14,000 in jewellery, and settled upon her £800 per annum for life as a compensation for his misconduct, his income at this time being not more than £1,250 per annum. Although his wife cohabited with another man, Windham again lived with her, &c. &c. He was fond of dressing and acting as a detective, railway guard, and of driving trains, &c. The Lords Justices appointed Dr. Forbes Winslow and Dr. Mayo as examiners, with Dr. Bright as assessor. There were two interviews of three hours in all. It was found difficult to keep his attention fixed on any one point. Drs. Winslow and Mayo, and Dr. Southey (also appointed by the Lords Justices), all considered him imbecile. On the other hand, Dr. Tuke, Dr. Seymour (eight years a Commissioner in Lunacy), and Mr. Hancock, Dr. Hood, of Bethlehem Hospital, Dr. Sutherland, and Dr. Conolly, all considered him of sound mind. The Master in Lunacy, Mr. Warren, in addressing the jury, said: "The question to be decided was, not whether Mr. Windham was absolutely insane, but whether there was such imbecility of mind, not amounting to actual insanity (!), as to render him unable to act with any proper or provident discretion, or to render him liable to be robbed by any one. The broad question was, whether he was of sufficiently sound mind to be entrusted with the management of himself, and of his affairs. Mere weakness of character, mere liability to impulse, good or bad, mere imprudence, recklessness, and eccentricity, to which might be added immorality, did not constitute unsoundness of mind, unless in looking first at the whole of the evidence, there was good reason to refer them to a morbid constitution of the intellect. They might furnish evidence of unsoundness, but they did not constitute it."

Mr. Windham then underwent a private examination before the jury; and it is said that he gave proper answers to the various questions put to him. The jury, by a majority of fifteen to eight, returned the following verdict:—"That Mr. Windham is of sound mind, and capable of taking care of himself, and of his affairs." After this verdict, he was guilty of other eccentric acts, exhausted a splendid fortune, and became a bankrupt! (It is worth while referring to Dr. Taylor, and to the Newspapers of the time, to read the severe, and often unjust, strictures of the medical evidence in this case. Some of Mr. Windham's relatives appeared in no very favourable light on the trial. Whenever they could make an advantageous bargain, they considered him sane; when they "stood to lose" by him, they denounced him as imbecile and demented!)

CASE VI.—*Case of Hadfield and Truelock, tried in* 1800, *for shooting at King George III.*

[Beck, *loc. cit.*, p. 429, who refers to "Collinson on Lunacy," vol. i., p. 475.]

"Hadfield's insanity had been of some years' standing, owing to a wound of the head received in battle; he had repeatedly, in these paroxysms, attempted murder, and a day or two before the act he attempted to kill his own child. Hadfield shot at the King on the persuasion of Truelock, a maniac, who prophesied that the Messiah should proceed from his mouth, and told Hadfield that the only obstacle was the King, who must first be dispatched. They both became tenants of Bedlam for life. Hadfield was still alive in 1823, and may be at present (1836). At the time now referred to, he did not evince any symptoms of insanity, but his impatience of confinement had soured his temper, and he was constantly grumbling and discontented. He was cleanly and regular in his habits, and made handsome straw baskets, which he sold." "Sketches in Bedlam," London, 1823, p. 18.

Case VII.—*Regina* v. *Pate.*

The prisoner was indicted for an assault on the Queen (Central Criminal Court in 1850, Taylor, *loc. cit.* p. 561). It was proved that he was guilty of strange and eccentric, and even of that which some might call insane conduct, but there was no evidence to show that he had not a rational control over his actions. Dr. Conolly admitted that the prisoner was labouring under no delusion, that he knew the distinction between a right and a wrong action, but he was subject to sudden impulses of passion. He attributed his act to some sudden impulse which he was quite unable to resist. The late Baron Alderson, who tried the case, observed in charging the jury, "That it was not because a man was insane that he was unpunishable, and he must say that upon this point there was generally a very grievous delusion in the minds of medical men. The only insanity which legally excused a man for his acts, was that species of delusion which conduced and drove him to commit the act alleged against him. They ought to have proof of a formed disease of the mind; a disease existing before the act was committed, and which made the person accused incapable of knowing, at the time he did the act, that it was a wrong act for him to do." The jury convicted the prisoner, and he was sentenced to transportation ("Med. Gaz.," vol. 46, p. 152; "Journ. Psychol. Med.," 1850, p. 557). Dr. Taylor remarks that "Here the defence of insanity was advanced upon very weak grounds. Had the prisoner assaulted a policeman instead of the Queen, he would have been fined or imprisoned, and nothing heard of the plea, although the rank of the person assaulted can make no difference respecting the existence or non-existence of a diseased state of mind" "Journ. Psychol. Med." 1859, p. 445; remarks by Dr. Forbes Winslow.

Francis, who shot at the Queen, was convicted.

Oxford, who did the same, was acquitted.

Arthur O'Connor made an attempt on the life of the Queen in 1872. Hereditary taint and feeble-mindedness were proved, but the Court was not satisfied, and he was convicted. We believe, however, that his sentence was afterwards commuted to detention in Broadmoor Criminal Lunatic Asylum.

N.B.—The frequent attempts made on the lives of kings and queens, prime-ministers, and eminent persons, may almost be held to constitute a species of insanity by themselves. Apart, however, from strong political feelings, and the desire of revenge, which are sometimes the motives, there can be little doubt that many of these crimes are committed for the same reason which led to the burning of the Temple of Diana at Ephesus, by Herostratus, and of York Minster by Martin—the foolish love of notoriety in weak-minded persons,—

> "The fond attempt to give a deathless lot
> To names ignoble, born to be forgot!" *

CASE VIII.—*Case of James Gibson, commonly known as "Daft Gibson."*

[Edinburgh High Court of Justiciary, Dec. 23, 1844. *See* "Ranking's Abstract," vol. i., Jan.—June, 1845, p. 383; and the "London and Edinburgh Journal of Medical Science," Feb., 1845.]

"James Gibson was a weaver. He was tried for *fire-raising* before Lord Justice-Clerk Hope and Lords Moncrieff and Cockburn. The case was one of those difficult ones, which we may expect to be of frequent occurrence, where the words and actions of a sane man were, both before and after the trial, so mixed up with symptoms of unsoundness as to lead some parties, and amongst the number one medical witness, to believe that the man was feigning. The evidence of several witnesses who had known Gibson previous to the fire-raising, was to the effect that they thought him of weak mind, and he was very generally known as 'Daft' Gibson. It was also distinctly proved that he had been subject to delusions. The evidence of the medical men confirmed the statements of other witnesses; and eight out of nine medical men, of whom the greater part were either practically versed in diseases of the mind, or prepared by the nature of their studies, and their general talents and acquirements, to form a trustworthy opinion, were in favour of the prisoner's insanity. The judges' charge, in face of this decided balance of opinion, was strongly against the prisoner's insanity, and the evidence of the medical witnesses was under-valued to an extent unusual even in a court of law, while the jury were flattered by being told that they were in a better position to judge of the real state of the prisoner's mind than the medical witnesses, who had repeatedly and carefully examined him! The jury unanimously found the panel 'guilty as libelled,' and consequently disallowed the plea of insanity. The case is one deserving of more minute examination than our space will allow us to devote to it. The judges' charge especially invites comment, and no part of it more than the statement that the question whether the delusions were real or feigned 'was purely a jury question.' One of the most difficult and delicate questions in the world purely a question for a jury! The writer of this has since been informed that James Gibson, prior to the carrying of the sentence of transportation into effect, was lodged at the Millbank Penitentiary, where he had not been more than a day when the physician of that establishment, with the concurrence of an eminent surgeon, sent him off to Bethlehem Hospital as being decidedly insane. This he did in entire ignorance of the particulars of his case, or the fact that the plea of insanity had been raised in regard to him. Gibson was detained at Bethlehem as a proper subject of treatment."

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* Cowper.

CASE IX.—*Imbecility, with Homicidal Mania.*

[Dr. Guy, *loc. cit.*, p. 178.]

Some years since a Commission of Lunacy was granted in the case of a young gentleman aged twenty, who was the slave of a childish fancy for *wind*-mills, with an aversion equally strong to *water*-mills. Having been placed under control in a place where there were no wind-mills, he cut the calves of a child's legs through to the bone, and stated that he should have taken away its life, that he might be tried for his act, and removed from a place where there were no wind-mills. He had always been violent when thwarted in his fancy, had threatened his keeper and members of his family, and had more than once made preparations for committing murder.

CASES X., XI., AND XII.—*Masked Epilepsy, Homicidal Mania.*

[Dr. Guy, *loc. cit.*, p. 216.]

A shoemaker, subject to epilepsy, was often furious for some time after the fits, but sensible, amiable, and industrious in the intervals. One day, when in the gloomy and morose state of mind that often precedes a fit, he met the superintendent of the asylum, to whom he was much attached, and stabbed him to the heart. He had not had a fit for three weeks, but the night following the homicide he had a severe fit, and for some time the attack continued to be frequent and severe.

A peasant suffered from epilepsy from his eighth to his twenty-fifth year, when, instead of epileptic attacks, he was seized with an irresistible impulse to kill. He felt the approach of his attack sometimes for days beforehand, and begged to be restrained. "When it seizes me," he said, "I must kill some one—were it only a child!" Before the attack he was very weary and depressed, could not sleep, and had slight convulsions of the limbs. Quoted from "Marc," by Maudsley ("Physiology and Pathology of the Mind," p. 309).

See also the cases in Trousseau referred to at page 846.

The "Finsbury Square Murder" was committed by an epileptic waiter, who imagined that he had "killed the devil." He made no attempt at escape, and indeed was the first to inform others as to the murder.

CASES XIII., XIV., XV., XVI., AND XVII.—*Homicidal Mania.*

[Abridged from Beck, *loc. cit.*, pp. 435—443.]

Robert Dean, a young man of weak intellect and strong animal passions, became warmly attached to a female superior in station to himself, and was rejected. This caused ungovernable feelings of revenge, and he determined on her murder. He had at the same time some religious ideas; it occurred to him that she was unprepared to die, but the impulse to shed blood had taken irresistible possession of him. There was a child, of which he was very fond, and whom he had often caressed, who, he concluded, had fewer sins to answer for, and this he determined should be the victim. He murdered it, and then gave himself up to justice. He was tried, condemned, and executed, in the county of Surrey, in 1819. The act, itself a sufficient proof of insanity, was strengthened by insane notions and actions, and absolute raving, even on the scaffold.

John Howison, aged forty-five, a sturdy beggar, but formerly a petty pedlar, was tried before the High Court of Justiciary in Scotland, December 31st, 1831, for the murder of a widow called Geddes, on the 2nd of that month. When taken he denied all knowledge of the murder. He did not rob her, although he might easily have done so. Drs. Spens and Watson visited him several times in gaol, but could discover no signs of insanity. He appeared, however, to be of low and weak intellect, and to be possessed of much cunning. A woman who knew him deposed at the trial that of late his habits had altered; he had become filthy in person and peculiar in mind. He was solitary and silent, living alone with a cat and a child, salting his bed and head; wearing a Bible round his waist, or round his head; sitting for hours brushing away imaginary flies; and possessing an insatiable appetite, eating half a peck of potatoes, with one or two pounds of bullock's liver, almost raw and generally filthy, with two-penny-worth or three-penny-worth of bread at one meal. He often wounded his hands, wrists, and arms, with needles and pins, and would suck the blood. When asked why he ate his meat raw, he said "he liked the blood." He had taken a fancy to be a Quaker, but at the meetings he paid no attention to the worship, only muttering to himself, and pricking himself with pins and needles. The medical defence was imperfect, as some of the witnesses had never seen him. They considered his insanity to consist in *a sudden morbid impulse to commit murder*. Howison was convicted, and the Home Department refused leave for additional proofs of insanity, consisting of unprovoked and boisterous acts of violence, to be adduced. The evening before his execution he accused himself of eight murders, which were supposed to be pure delusions. His voracious appetite continued to the last. ("Edinburgh Med. and Surg. Journal," vol. 38, p. 51; "Edinburgh Law Journal," vol. 1; "Medico-legal cases of Homicide," by A. Watson, Esq.)

Louis Papavoine, first clerk in the Port of Brest, had always been unsocial and melancholic, and much addicted to solitary walks. During the last year of his clerkship he seems to have had a delusion or a dream that some one wanted to kill him in his sleep. This lasted ten days. He soon after took charge of his father's business as a woollen clothier, and got involved in difficulties. In September, 1824, he complained of illness. He was ordered change of air. He began to doubt if his father and brother were really dead. On October 3rd he received good news of the business and went to Paris. Five or six days after, he suddenly murdered two children who were strangers to him, in the presence of their nurse. He had bought a knife just before. He escaped, and when taken and accused, declared that he mistook the children for those of the Duc de Berri. He then set fire to his bed, stabbed a fellow prisoner, and was hardly restrained from murdering him. It appeared on the trial that his father had been subject to mania, and was generally a morose, melancholy man. The prosecution, however, believed that the accused was a ferocious criminal, and that his conduct in prison was feigned. The jury found him guilty. He was condemned to death, and executed on the 19th of March, 1825. When interrogated, he defended himself with some ingenuity. ("Causes célèbers du dix-neuvième siècle," vol. 1, pp. 203—290.) A perusal of this trial leaves hardly any reasonable doubt as to this man's insanity.

Dr. Prichard, in his article *Soundness and Unsoundness of Mind* in the "Cyclopædia of Practical Medicine," quotes the following from "Marc." The servant of a German mistress begged the lady to discharge her. She said that whenever she undressed the child she nursed, its white skin tempted her to murder it, and tear it to pieces. She was afraid she could not resist the desire, and preferred to leave the house. This occurred in Baron von Humboldt's family. A young lady in a French asylum used every now and then to experience a violent desire to kill somebody, and would at such times ask for a strait-waistcoat, and to be carefully guarded until the paroxysm was over.

A distinguished chemist and poet, naturally mild and sociable, voluntarily sought safety in a lunatic asylum. Tormented by the desire of killing, he often prayed most earnestly at the altar to be delivered from such a horrible feeling. In the asylum he would go to its director and ask to have his thumbs tied together with a riband. This slight ligature was sufficient to calm the unhappy R———, who, however, finished by endeavouring to kill one of his friends, and perished in a violent fit of maniacal fury.

Henriette Cornier, aged twenty-seven, a French servant, naturally gay, amiable, mild, and fond of children, became silent, melancholy, and absorbed in reverie in June, 1825. She was dismissed from service, and fell into a state of permanent stupor. In September she tried to drown herself in the Seine, but wás prevented. Employment was again procured for her in October. On the 4th November she took home a beautiful child of a neighbour's, a girl aged nineteen months, and cut its head off. The poor mother came to seek her child. Henriette, perfectly calm, said, "Your child is dead." As the mother forced her way into the room, Henriette threw her head into the street. When arrested she was found sitting on a chair near the body of the child, gazing at it, with the bloody knife by her, and her hands and clothes covered with blood. So far from denying or excusing the crime, she confessed it, and said with indifference, "I intended to kill the child." MM. Adelon, Esquirol, and Léveillés, could find no positive proofs of insanity, but did not deny she might be insane. She was confined in the Salpétrière, but the repeated examinations of the physicians do not appear to have led them to any definite opinion of her insanity. The Advocate-General at the trial treated the existence of monomania as a mere fancy invented for the purpose of paralysing the hands of justice. The jury found her guilty of voluntary, but not premeditated murder. She was sentenced to perpetual imprisonment with hard labour, and to be branded. She heard the sentence without betraying the least emotion.

Similar cases might be multiplied almost indefinitely. Drs. Prichard and Esquirol agree that homicidal or androphonic insanity offers the following characters :—

1. The homicidal acts of insane persons have generally been preceded by other striking peculiarities of action, noted in the conduct of these individuals, often by a total change of character.

2. They have often been discovered to have either committed suicide

or to have expressed a wish for death, or to have even wished to be executed as criminals.

3 Their acts are motiveless, or in opposition to the known influences of all human motives. A man, known to be tenderly attached to them, murders his wife and children; a mother destroys her infant; (or the victims are perfect strangers).

4. Their subsequent conduct is characteristic; they (seldom) seek escape in flight, even deliver themselves up to justice, acknowledge their crime, describe their state of mind, or remain stupefied and overcome by the horrible consciousness of the atrocious nature of their deed.

5. The [ordinary] murderer has generally accomplices in vice and crime: there are assignable inducements to lead to the commission of the murder—motives of self-interest, of revenge, displaying premeditated wickedness. The acts of the madman are in some instances of this character, but the premeditation is peculiar and characteristic.

CASES XVIII. *and* XIX.—*Cases of the Duchess of Manchester and Mr. Dyce Sombre. Testamentary Capacity.*

[*Duke of Manchester* v. *Bennett.* Kingston Lent Assizes, 1854. Taylor, *loc. cit.*, p. 551.]

"The duchess had made a will, which was disputed on the ground that, from bodily illness and mental infirmity, she was not at the time competent to dispose of her property. In 1843 she had made a will, bequeathing her property to her children; in 1848 she made another will, revoking that of 1843, and bequeathing the absolute control of her property to her husband the duke. This second will, which was executed on or about the 26th October, 1848, was the subject of dispute. It appeared from the evidence that the duchess had been seized with hysteria and strong convulsions on the 12th of September preceding, but her mind was not then affected. On the 1st of October she was again attacked with convulsions, and, according to some of the witnesses, she laboured under acute mania, with symptoms of inflammation of the brain. She died on the 21st of November, about three weeks after the execution of the will; and there was evidence to show that she had some delusions both before and after its execution. A physician, who was the medical attendant of the family, and was one of the witnesses to the will, deposed that on the day it was signed, and for some days previously the duchess had recovered her reason, and that at the time of signing it she was, in his judgment, aware of what she was doing, and that she voluntarily delivered it as her own act and deed. It appeared also that the disputed will was substantially such as the duchess had announced her intention to make long before the execution of it, and when it was not suggested that she was in an unsound or incompetent state of mind. Three medical men of eminence were called on the part of the defendants, and expressed their opinions, from the evidence, that the deceased at the time of making the will was incompetent to make it; that, in fact, she was proved to have been insane, and there was no medical evidence that she had had a lucid interval. These opinions were based on the nature of the illness, its duration, and the probability (for there was a want of any direct evidence on this point, except that which showed the duchess to be in a sane and disposing state of mind) that this illness still affected her mind when she executed the will. The point at issue then was, "Was she, or was she not, in a competent state of mind at the time of executing the will? The jury found that she was competent, and that the will was valid; but a new trial was subsequently granted by the Vice Chancellor. This did not take place, as the case was ultimately arranged without it."

Dr. Taylor (from a careful consideration of the evidence given at the trial) concludes that the duchess was never really *insane* at all, but only suffered from delirium at times, due to her bodily illness, a state quite compatible with perfectly lucid intervals of perfect sanity. He very justly remarks, that it is much to be regretted that she was not asked by her medical attendant (who was also a witness to the will) to state the amount of her property, and her wishes concerning it. Had she done so, in clear and intelligible language, there would have been little room for dispute as to her intentions or her sanity.

The will of Dyce Sombre [Prerogative Court, Jan. 7, 1856], dated in June, 1849, gave rise to a litigation in reference to the alleged insanity of the testator. The deceased was the subject of numerous inquisitions, some of them undertaken at his own request, and the results were variable. On some of these inquiries he was pronounced to be sane, and competent to manage his own affairs, an opinion also entertained by some English and French physicians. By others, again, it was considered that during the whole period of seven years his mind was still infected with certain delusions respecting his wife and her relations. Drs. Seymour and Ollife, who had been attesting witnesses to some of the testamentary papers, considered him to be of sound mind at the time of signing them. This might, however, be consistent with the existence of some delusion in reference to the disposition of his property. Sir John Dodson, in delivering judgment, said: "A person might manage his property exceedingly well to a certain extent, and yet be labouring under insane delusions; and any insane delusion whatever operating on his mind would, according to the law and practice of the Court, render him incapable of making a will. But supposing these gentlemen thought him capable in June and in August, 1849, what was to be said as to the publication of a book by the deceased, called the 'Refutation,' which took place very shortly afterwards, and which must have been in preparation when the will and codicil were executed? It contained statements which showed that the deceased could not have been of sound mind when he composed it. Under these circumstances the Court could come to no other conclusion than that he laboured under insane delusions in 1843, and that he continued to entertain them when the papers propounded were executed."

The Court, therefore, pronounced judgment against the will and codicil. In this case the delusions had never been entirely eradicated from the mind of the testator. There is, however, a difference between unsoundness of mind represented by incompetency to manage affairs, and that defect of mind which deprives a man in the legal sense of the power of disposing of his property by will. A mind may be clear enough for the performance of some of its functions, and yet not clear enough for the performance of others. A man may give clear and reasonable directions for the preparation of a will, and even sign it in a natural manner, but he may be governed by caprice and passion, amounting to insanity in the disposition of his property. It has been well remarked that "so long as human nature is the mysterious phenomenon that it is, and the empires of reason and unreason border so closely on each other, we must expect often to err, when we try to discover whether a man, alternately the subject of both, was in or out of his mind at any given moment. A disposing power may exist in the mind of a person not legally competent to manage his affairs. The criteria applied are different, and the existence of such a power must be a matter to be proved by evidence in each particular case."

N.B. These two cases are taken almost *verbatim* from Dr. Taylor, whose large work contains a number of other will cases, remarks on eccentric wills, and other illustrations of the medico-legal relations of insanity.

CASE XX.—*Insanity and Epilepsy Feigned by a Prisoner.*

[Case reported by Dr. Lunier, of the Blois Asylum. Laurent's Eighteenth Case, *loc. cit.*, p. 258, &c.]

Bimbinet Constant, aged twenty-nine, vine-dresser, married, and of good constitution, was admitted to the Asylum on January 6th, 1860, the physician of a prison having certified that he was suffering from acute mania. His symptoms seemed to confirm this at first. There was a history of an accident to his head five or six years before. This was not confirmed by his sister-in-law. He complained of being tormented by strange *ideas,* which made him sit up many hours at night. In the day he kept walking about, making the sign of the cross, and striking his breast, turning his eyes towards heaven. On January 17th he was found lying in the court-yard, with his face to the ground, two or three yards outside the wall. The keepers thought he wanted to escape, and did not notice anything peculiar about him. On being interrogated, he said he felt giddy and faint. There were, according to him, no warnings, and no sequelæ. He presented no signs of a recent severe fit. On the visit of the 23rd the doctor found him in tears; he was, he said, "*agitated by a great desire to see his little children.*" The keeper had offered to write for him, but he refused; "for," said he, "*the director might then see that I am quite in my right mind.*"

On the 30th, after the indictment had been read over to him, he was attacked with another of his fits. On the doctor being called, he found him with convulsions of the face, limbs, trunk, and eye-balls. The pupils, however, contracted readily, and appeared normal; he did not foam at the mouth; he had not vomited, though he had just eaten; his pulse was 80—88. He did not pass urine in the fit. Suddenly touched with a hot key, he winced and withdrew. But on a second occasion, when he could see what was going to be done, he bore the pain unflinchingly. This fit was followed by no prostration or weakness. Two hours after, when watched, he was seen murmuring prayers, his arms crossed on his breast. Then finding he was watched, he cried out suddenly, stretching his arm out, with the fist closed, "*If I had a sword, I would kill him!*"

On February 2nd, the doctor sent for him at two P.M., and talked seriously to him, telling him that it was against his interests to feign insanity. He replied, "*I'm not mad at all; and I'll give you* 200 *francs (£8) if you'll let me escape."* The evening before he had answered sensibly to questions about the indictment. To-day he denied all knowledge of his partners in guilt, and then a little later admitted the falsity of this denial. Next day he feigned imbecility before his own advocate; but on the above facts being alluded to, he abandoned this *rôle,* and recovered his memory and his intelligence. Next day he admitted his sanity, and that he had shammed the madness. He persisted, however, that the fits were real. In the face of the man's admissions as to his imposture, and looking at the peculiar and unusual nature of the fits, M. Lunier concluded that these also were feigned, and reported accordingly.

CASES XXI. *and* XXII.—*Feigned Insanity, Silly Answers to Questions.*

["Laurent," *loc. cit.*, p. 103, and p. 106.]

A prisoner, called Rambaud, was sent from the assizes at Nancy to the Asylum of Maréville, that Dr. Morel might report as to his insanity or otherwise. On the day of his arrival, he appeared to be in a state of fury, excitement, and exalted ideas. He dashed at the keepers, and his language seemed as disordered as his actions. He was asked his age: he replied, "It is quite ten miles to Nancy." Asked what countryman he was—*Answer*: "Oh! you want to assassinate me, do you—you—you? Don't hide yourselves. You are disguised. You know!" "Are you married or single?" *Answer*:—

"'Oh, well a day, upon my life,
You're well acquainted with my wife!'

Yes! I'm married. No! I'm not married," and so on. This man had long pretended to be a deaf mute. Placed amongst such, with an officer who pretended to be so in order to watch him, he was caught talking to himself. On his discharge he shammed again, to gain charity, but forgot himself one day when very drunk. After this followed the fury and wild talk mentioned above.

Snell, in the Berlin "Medical Zeitung," gives the following case:—

Catherine R——, a widow, bought a house, and did not like it. To annul the contract, her children said she was insane. The Court appointed three experts to report on her case. They found an aged woman, almost blind from cataract. Her features expressed a stupid look of don't-care-ish-ness (insouciance). She could not look any one in the face, but kept her eyes always on the ground. She could not, however, succeed in quite fixing her expression. One doctor asked her to read or write; she said she could not [which was probably true]. She was then asked to count, and she did so thus: 1, 2, 4, 6, 7, 8, 10, 11. 13, 18, 19, 21. Asked how many fingers she had on each hand; she hesitated; after a bit she said *four*. Asked to count her fingers, she left out the *ring*-finger every time, and counted thus: 1, 2, 4, 6. Asked how many two and two made, she said, after some hesitation, *six*. Other questions and anwers were as follows:—

Q. How many children have you?
A. I believe I have nine. [She had seven really.]
Q. How long has your husband been dead?
A. About ten years. [Five years was the truth.]

Q. What did he die of?

A. He was ill more than a week. [In reality he was killed instantly by a fall.]

Q. Do you know this daughter of yours? [Her daughter Catherine.]

A. Yes.

Q. What is her name?

A. Babetta.

Q. Have you any other relations?

A. Yes. I've a sister, Barbara. She's married to a man called Prince. Send for her, for she never comes to see me. [Her sister had long been dead.]

Q. What year is this?

A. I don't know.

Q. How long is it since Christmas?

A. I don't know.

Q. Have you bought a house?

A. I don't know. I've got one house; why should I buy another? There are folks who want to buy my house.

Q. Where do you live?

A. I don't know.

Q. What use do they make of the monastery at Eberback?

A. There are monks living there. [There had been none for fifty years.]

Q. Have you eaten anything to-day?

A. No. [She had just done so.]

Q. What did you eat?

A. Potatoes. [She ought to have said soup.]

Q. What sort of wine did last year's vintage afford

A. Very good indeed. [It was really very bad.]

Q. What is your clergyman's name?

A. Ohler. [It should have been Muschka.]

Q. Do you know the Ten Commandments? If so, tell us the first.

A. "I am the Lord thy God," &c.

Q. What is the second, then?

A. "I am the Lord thy God," &c.

Q. What is the third?

A. I don't know.

Q. The fourth?

A. I don't know.

Q. The fifth, then?

A. "Thou shalt *not* honour thy father and mother."

From this fencing with the questions, the experts decided that she was feigning. The witnesses for her were condemned for perjury. She was condemned to the House of Correction, for deceit and exciting to perjury. After this sentence, she gave up her shamming, and no longer simulated insanity.

[M. Laurent, *loc. cit.*, gives many other cases of feigned insanity. It is noteworthy that in some cases the prolonged feigning appeared to impair the soundness of the mind, so that those who shammed at first became really insane in the end. *See* Remarks on Feigned Diseases.]

Case XXIII.—*A genuine Will annulled. Dementia, Monomania of persecution.* Suicide *by means of a guillotine made by himself.*

[Tardieu, *loc. cit.*, p. 375, &c.]

This is Tardieu's Case XVI. On the 24th of April, 1862, M. C. H. C. killed himself by means of a guillotine, which he had taken two years to design, make, and perfect. He had long been demented, and in 1847 was placed by the authorities in an asylum. In 1851 he was also declared incapable by the civil tribunal of Largres. When he died there was a will in his lawyer's hands dated August 21st, 1843 ; in this he left his cousin, Miss L. C., all his property. There was also a codicil or writing, entitled " A note of explanation to be added to my will," of the same date. His brothers and nephews disputed the will on the ground of insanity. These were the heirs-at-law, or natural heritors. They alleged that as far back as 1836 the testator, who had always been flighty from a child, was attacked by a monomania of persecution, and of hate against his father, brothers, and other members of his family, whom he causelessly regarded as enemies. This monomania increased, and under its influence the will and codicil were written. Miss L. C. rejoined that he was quite sane when he made the will, and that there was nothing in that document to prove him insane. The Court decided against the will, and condemned Miss L. C. in costs, whilst admitting that at the time the testator made it he may have been highly intelligent, especially as it was made some years before his dementia. But the Court considered that his delusions of persecution and groundless idea that all his relatives were plotting against him, which were clearly seen in the codicil or explanatory note, proved that he was even then suffering from monomania, and therefore not of sound mind in the sense of Article 901 of the Code Napoléon.

Case XXIV.—*Medico-legal Inquiry in a case of Melancholia, with Delusions as to poisoning [Monomania of persecution by poison]. Questions as to the setting aside of a Will, partly decided by the Will itself.*

[MM. Baillarger and Tardieu.]

This is M. Tardieu's nineteenth case, *loc. cit.*, p. 400, &c.

The questions submitted were :—

1. Was M. Béron a monomaniac in the last years of his life? and
2. Does the will, written, by his own hand, under the date of May 8th, 1865, furnish proof of this monomania.

The whole case is very interesting, but it must suffice us here to state that, as far back as 1855 or 1856, in fact the last ten years of his life, he accused almost every servant in his employ of wishing to poison him, or of having done so. First, he said a woman called George put poison in a plate of beans in 1856. He drank a lot of oil, and said that if he had not done so he must have died. He told everyone of this. Jenny Boutin, who lived nine years with him, was next accused of putting poison into some powders sent by the doctor. Next, a man called Brun was accused. Then a woman named Miaille, and a married pair called Fourcassié, whom he had earnestly begged to enter his service, and to whom he had seemed warmly attached. He fancied that he *heard* the man tell his wife to put poison into his food. After this he kept no cook "in the interests of his health." Anne Bulan came to kill and to pluck his poultry, which he trussed and cooked himself. His doctor, M. Musset, says "this idea of being poisoned entirely dominated him."

Like all reasoning monomaniacs he sought for proofs of his ideas. Marie Richard says that he showed her the yellow stains on his linen, due to perspiration, as proofs of poison; and his washerwoman, Marie Léon, says that he bade her notice the reddish stains under the armpits, produced by perspiration, as the results of the poison which he said was given him by the woman Miaille. Joseph Duvour states that he showed him one of his testicles, alleging that it furnished proofs of the same woman's attempt to poison him. From 1861—1863 he had illusions of the senses of sight and hearing. He heard and saw imaginary people, and fancied that real persons were in the house, talking together, plotting against him, &c., when they were really not so. At the same time, most of the witnesses declared, that in other respects except these delusions, and this monomania, he seemed as intelligent as ever. Amongst those he suspected were a priest and many respectable persons. In the will he left Pierre Miaille his sole legatee, in order that this child might, "by his attachment to him, enable him to bear, with less bitterness, *all the anxieties and torments which people delighted to inflict upon him*." He ordered 6000 francs to be invested for the repairs, &c., of his tomb. If this should not suffice, Pierre M. must pay the surplus from his own share. But he adds, "in case any bad people should cause P. M. more expenses than the legacy could defray, then," [says M. Bèron in the will,] "he shall not be compelled to repair my tomb!" It was clear that he fancied that his enemies ["the conspiracy of priests and women," of which he talked], might ravage and devastate his tomb!

The conclusion from these facts is obvious: the reporters considered the monomania clearly proved.

A number of analogous cases are contained in M. Tardieu's valuable book. Those in which politics played a principal part are of great interest, though less common in our own country.

Case XXV.—*John Thom, the fanatic. The Canterbury Riots.* We take this case from the "Modern Newgate Calendar."

[Maidstone August Assizes, 1838.]

In the year 1833 a fanatical person, who called himself Sir William Courtenay, a knight of Malta, arrived in Canterbury, and took up his quarters at the Rose Inn. He was supposed by the populace to be gifted with miraculous powers, and many deluded persons in Kent believed him to be of Divine origin. He often harangued the farm-labourers and others on the bounty of providence and the cupidity of man. The simple peasantry looked on him as a prophet sent from God, to make bread cheaper, and to redress poor men's wrongs. He offered himself as a candidate to represent Canterbury in parliament, but was, meanwhile, arrested for perjury, tried at the Maidstone Assizes in July, 1833, for this crime, and condemned to imprisonment and transportation. This sentence was commuted, as he was proved to be insane; and he was confined in a lunatic asylum. There he seemed rational, and after four years was liberated. He took lodgings at Fairbrook, near Broughton. "*This* *place,*" said he, "*is very convenient, for the saints can march quickly on Canterbury, and give the cathedral to the flames, if such be the decree of the armed angel of heaven.*" He then began to preach, and finally succeeded in raising a large mob, armed with all sorts of weapons. He first fired on one constable, killing him, and stabbed another with a dagger. He declared that he was Christ come down from the cross. He shot the commander of the troops brought against him, whilst this young lieutenant was trying to avert bloodshed. Another soldier was killed and one wounded. Thom himself was killed, and is buried at Herne Hill. On the side of the rioters eight men were killed, and nine wounded. His accomplices, Price and Mears, were sentenced to death, but not executed--the former being transported for ten years, and Mears for life. Thom himself was clearly a lunatic of a most dangerous class. Revolutionary epochs furnish many similar examples.

Case XXVI.—*Dementia, or Puerperal Insanity—Lady Mordaunt's case—Insanity pronounced a cause for Divorce.*

[Dr. Taylor, *loc. cit.*, 511—514. See also the Medical and other journals for 1870—5, especially the "Journal of Mental Medicine." Court of Divorce, Westminster, 1870 and 1875. House of Lords in the *interim*].

Soon after her confinement, this lady, who was one of a family celebrated for their beauty and *esprit*, confessed that she had committed adultery. Her husband then took proceedings for a divorce. When served with the writ, April 30th, 1869, it was alleged that she was insane, and unfit, from mental incapacity, to instruct counsel or solicitors. On the part of Sir Charles Mordaunt, the husband, it was alleged that she was really fit and competent, and only assumed the state of insanity to avoid a public trial [The Mordaunt Divorce Case. Official Report, 1870, p. 108.] Lady Mordaunt's confinement occurred on February 28th, 1869. On March 9th she informed her husband that the child was not his. At first he treated this as a delusion, but certain circumstances and rumours coming to his knowledge, he believed it to be true, or at all events said that he so believed it. An entry in Lady Mordaunt's diary, about the 3rd April, 1869, was remarkable. The entry against the date was 280 days from the 27th of June [1868]. It appeared that Lord Cole had stayed at Lady Mordaunt's on that date till 1 a.m. on the 28th, Sir Charles Mordaunt being then absent. Other visits of the same nobleman were proved. The monthly nurse swore that she saw no signs of insanity about Lady Mordaunt. Mr. Orford (her accoucheur), who attended her till the 18th of March following, also deposed to the absence of symptoms of puerperal mania, or fever, and of delusions. "He considered that she was shamming on the 8th of March, after her confinement, and more or less from that time until May 13th. The only symptoms exhibited were silence and a fixed look. He saw her again at Worthing on July 10th. Nothing then seen led him to believe that she was not in her senses. There was no sign of madness about her at any time. Her present state (1870) is that of a mind altogether gone. She cannot apprehend anything that is said to her." (Report, p. 86.)

This witness, as it appeared, had little or no experience in mental diseases in general, or puerperal mania in particular. Dr. Jones gave similar evidence. He also could see nothing till the 10th July, when her mind, he thought, was impaired. Dr. Tyler Smith, called as an expert, thought there was no evidence of puerperal mania following the confinement, and there was an absence of insanity at the time spoken of by the two witnesses mentioned. He saw Lady Mordaunt twice in December 1869, and saw no symptom which might not easily have been feigned. He would not, however, say she was feigning, and thought the appearances might be those of dementia. [The medical evidence for the petitioner, and against Lady Mordaunt, was thus extremely weak, and almost parrot-like in its repetitions. The only skilled witness called (Dr. Tyler Smith) declined to accuse Lady Mordaunt of feigning]. On the other side, it was proved by the evidence of three female attendants (from May 17th to August 31st) that Lady M.'s habits had become filthy, and quite inconsistent with sanity. She destroyed her clothing, and was unclean in her person. Drs. Priestly, Tuke, Sir James Alderson, Sir William Gull, and Sir James Simpson, all saw her at various times, most of them repeatedly, and all agreed as to her mental condition being one of insanity. Most of them considered it to be puerperal insanity, and to have terminated in dementia. They also agreed (or nearly all of them), that self-accusations of unchastity were not uncommon, were indeed almost the rule in such cases. [This the authors can abundantly confirm from their own experience.] Dr. George Burrows and Dr. Russell Reynolds arrived at similar conclusions. Although the latter said he could not arrive at any conclusion, "he thought there was either extreme disease or extreme shamming, and after all he had seen, he thought the former. He tried to detect simulation, but never saw any breach in her demeanour." In answer to the Court he said, "It is an unusual case, and there are some points of contradiction in it, such as the amount of intelligence shown up to a certain point, coupled with the uncleanliness which is generally confined to extreme cases of dementia. She can play an air, and sometimes answer sensibly on common things, and can write letters. It was this inconsistency which for some time made him doubtful." (Rep. p. 18.)

Dr. Wood said, "It is impossible that any human being should have carried out such a system of deception, such as that suggested by the petitioner. Lady Mordaunt's conduct was invariably consistent, whereas the most practised artist would have been betrayed into tripping. Simulation would have been betrayed by inconsistencies. Puerperal insanity may occur during pregnancy, at confinement, or during lactation. In the majority of cases it is more or less progressive. It is possible that Lady Mordaunt, though suffering from mania, was sane at the time of and after her confinement." The verdict of the jury was to the effect that on the 30th April the respondent was totally unfit to instruct her attorney, and had been unfit ever since. "The learned judge, in his instructions to the jury, put aside all these conflicting medical opinions. He did not know a more difficult definition to express in words than that of insanity. There was, he thought, as much variety in mental as in physical disorder. Instead of asking them to say whether the lady was mad or insane, he would wish them to consider whether she was or was not in such a state of mental disorder as to prevent her giving instructions." The jury found (as we have seen) in the affirmative. The petitioner (who seemed determined to get rid of his wife) appealed; and the case was carried to the House of Lords. It was decided that the case should be tried by the Court of Divorce, quite irrespective of the insanity or sanity of Lady Mordaunt, "that it should be tried on its own merits." It was so tried, and the number of co-respondents reduced from four to one. On this trial, which took place in March, 1875 [see "Standard," March 11, 1875], the jury decided that the adultery was proved, and the Court declared a *decree nisi.* The case was again referred to the House of Lords, who confirmed the decree.

It is thus seen that insanity is no bar to a decree of divorce, a principle which seems to us far from being a safe one. In a case of murder the evidence of other persons or circumstantial evidence may be sufficient. In the relations of husband and wife, it seems hard to punish the wife whilst she is unable to defend herself. At all events, if the principle be admitted, it seems unjust that a poor labourer should have to pay towards the support of an insane wife in Colney Hatch or Hanwell, and be liable to a prosecution for bigamy if he marries again, whilst a wealthy baronet escapes almost scot free, and may marry again if he choose.

CASE XXVII.—*Case of Major Mitchill tried for wounding and maiming a boy eight years old.*

[Beck, *loc. cit.*, p. 448, "Boston Med. and Surg. Journal," vol. XI., p. 404].

"Major Mitchill, aged eleven years, was tried before the Supreme Judicial Court of the State of Maine, U.S., November, 1834. His victim was named David F. Crawford, and was only eight years old. Mitchill induced the younger boy, by threats, to go and gather flags with him. He soon began to whip the boy. In this sport he was stopped by a neighbour, who sent Crawford home. Mitchill, however, intercepted the child on his way, and after various threats carried him into the woods, threw him into the bushes, then carried him to a pond and thrust him in, took off his clothes, tied his hands, and then whipped him severely with withes. Finally, he took a piece of sharp tin, and cut out one of his testicles. After all this he beat him again! On the trial it was said by his counsel that Major Mitchill had, in early infancy, received a dangerous hurt on the top of his head, and that a striking malformation of that part now existed. The parents did not appear to prove the injury, but Dr. Mighels of Portland deposed that there was an unusual appearance in the construction of the head, a palpable depression on the cranium, and that the boy's right ear was lower than the left. His schoolmaster deposed that he did not learn so fast as others did, but made improvement. "He was more sly than other boys; he would watch me narrowly, and was mischievous if I turned my back. Punishment influenced his conduct. I do not consider him so bright as others, but far from being a fool." He had been punished for quarrelling. The jury found the prisoner guilty, and he was sentenced to nine years' hard labour in the state prison.

Mr. Otis, an attorney who published an account of this case, justly remarks, "that many are of opinion that utter fatuity in this convict is inferable, first from the very circumstances of the case, as made out upon the trial; next by the manner and terms of the boy's conversation in reference to the revolting subject of his crime; and lastly by his present appearance, his past history, and his peculiar physical conformation."

Andreas Bichel, who murdered young girls for the sake of their clothes, and opened their bodies from curiosity to see what was inside, and actually ate the raw and yet warm and quivering flesh, was in all probability a lunatic. [Feuerbach, *loc. cit.*, 2^er^ Theil, s. 1—17.]

CASE XXVIII.—*George Rede, the laughing Murderer.*

[Feuerbach's 4th case, *loc. cit.*, 2^er^ Theil, pp. 58—80.]

George Rede, aged fifty, married, with four children, was the terror of his wife and family and neighbours for many years, by reason of his cruel, violent, and evil disposition. He was passionate in the extreme, and used dreadful threats, sometimes resorting to violence. He had had some dispute with an honest, kindly old man, who was commonly called the Katzenberger (otherwise Andreas Rauscher). On June 23, 1806, at 9 a.m., Rede met this old man, who was haymaking, put a pitchfork to his breast, and threatened to kill him. The old man guarded himself with a scythe, and did not strike back, but succeeded in wresting the fork from Rede's hand. Rede ran back in a rage to his house, called his wife and two daughters, armed his wife with a big cabbage knife, one daughter with a dung-fork, the other with a hoe or hack, and himself with a scythe. Wife and daughter tried to keep him back—in vain—he rushed on, they followed. He then went to the old man, and rushed at him, cutting him about the head with his scythe. After this he took the dung-fork from his daughter, and struck and stabbed the old man with this. The murderer's wife ran away horrified with her daughters, and he continued to strike the old man, whose corpse exhibited some eight severe wounds. When he had killed him, he ran home laughing, delighted that he had struck the old fellow in the mouth!

At the trial he coolly confessed his crime, and seemed to glory in it, and only grieved because the scythe was damaged! He also said he thought he should deserve heaven by what he had done! It appeared also that when little more than fifteen he took a violent dislike to his mother, threw her goods out of doors, burnt her books, &c., and was so violent and outrageous that he was obliged to be put into irons. After this he was bled, which produced some change for the better, but it was necessary to confine him for a whole year. After his condemnation for the murder he became demented, and seemed to have lost all his memory, and all his intelligence. He was therefore not executed, but confined as a lunatic.

It would be easy to multiply cases of criminal lunatics, but it is unnecessary in a work of this kind. The authorities quoted above contain numerous examples. The "Edinburgh Medical and Surgical Journal" also contains, in its back volumes, many well-recorded cases, with comments.

On Actions against Medical Men on account of their having signed Certificates of Lunacy.

We had originally intended to devote some space to this subject. In speaking of certificates (page 866) we have quoted one such case, and spoken of the caution required in signing them. But an action may be brought, and sustained too in some cases, when medical men have not only acted *bonâ fide*, but skilfully, properly, and to the manifest benefit of the lunatic or sufferer from *delirium tremens* confined. Such instances of ingratitude are not uncommon. We may refer to the cases of *Mrs. Armstrong*, quoted by Dr. Taylor (*loc. cit.*, p. 598), Queen's Bench, February, 1858, as illustrating some of the difficulties caused by *dipsomaniacs*—to the case of *Symm* v. *Fraser and Andrews* (Queen's Bench. Dec., 1863), as showing that "no care or precaution in the performance of these responsible duties will always suffice to prevent a medical man from suffering a large pecuniary loss in order to vindicate his professional character and conduct in regard to the insane. Plaintiff was a woman who gave way to habits of drinking; she had had an attack of *delirium tremens* two years previously to the trial. The defendants attended her professionally. At her own request attendants were provided for her by her medical advisers, and these (necessarily) put her under a certain amount of restraint, by the authority, or at least with the consent of her physicians. Although the verdict was for the medical men, yet their expenses were heavy." *Roberts* v. *Hadden*, in the Supreme Court of Victoria ("Australian Medical Journal," Nov., 1873), illustrates the same point. Damages were laid at £3000, "in that he, the defendant, assaulted and beat the plaintiff, and gave him into the custody of a warder or attendant at the Yarm Bend Lunatic Asylum, and caused plaintiff to be imprisoned for a long time in the Asylum." The jury awarded one farthing damages! In this case Dr. Hadden had taken unusual pains to satisfy himself that he had good reason for signing the certificate. The plaintiff had already been confined in an asylum in Tasmania, and had acted with great eccentricity, and uttered violent threats against boys who were in the habit, he said, of annoying him.

ON FEIGNED DISEASES.

Some works on medical jurisprudence give elaborate directions for the detection of various impostures, and of feigned diseases and accidents. With the growing use of instruments of precision, and methods of physical diagnosis—such as the use of the thermometer, stethoscope, microscope, &c.—many of the old tricks have disappeared. Inflation of the scrotum to simulate hydrocele, or of the areolar tissue elsewhere to resemble œdema, would now only deceive a very careless surgeon. The use of pigments and irritants to simulate skin diseases, ulcers, &c., can also be detected by very simple means. Hæmorrhages can scarcely occur in any quantity, or for any length of time, without affecting either the pulse, temperature, or nutrition—though occasionally hysterical girls will lose much blood and be little the worse for it. Factitious worms, and foreign matters put into the urine, or into matters vomited, expectorated, or passed in other ways from the body, can be easily recognised by those familiar with the microscope. Thus the Authors have known the larvæ of common flies and *tous les mois* starch put into urine, fowl's blood (known by its oval corpuscles) represented as coming from the lungs, indigo and lamp-black used to simulate *coloured* *sweat,* and similar impostures. In any case of doubtful ulcer (say in the lower extremities), it is a good plan to *seal* up the ulcer, covering it with glass, or thin gutta-percha, or collodion, or mica, or some other transparent material, affixing *seals* to the bandages, &c. The weighing-chair would detect feigned starvation [*see* Chapter on Starvation]. In a Paper on "Malingering," by one of the Authors and Mr. J. Hutchinson, in Vol. ii. of the "London Hospital Reports," pp. 257—270, the following principles are laid down :—

1. That nearly all those who feign diseases or accidents are really in some way or other in ill-health ; or, in other words, that a basis of truth underlies most attempts at malingering. [It does not follow, however, that the *real* disease is the same as the one assumed. It is often quite different.]

2. That the difficulties in the detection of these cases are only to be fully met by a comprehensive knowledge of the real diseases, and by a constant study of human motives and actions.

3. That the resources of our art have been of late years so enriched by the microscope, ophthalmoscope, stethoscope, laryngoscope [thermometer], and other aids to physical diagnosis, and the apparatus of the chemist, that the detection of frauds is now much easier than before ; but that,—

4. In all cases of doubt, it is better to assume for the time that the patient's statements are true, than to run the risk of maltreating or neglecting a real case of disease. To these canons Mr. Hutchinson added the following remarks :—

"The importance of this rule can scarcely be exaggerated in its application to the casualty room of large hospitals. It is far better to allow nineteen knaves a temporary success in their schemes than to refuse relief to one really urgent sufferer. Cases come very frequently under my notice in which great hardship would have been inflicted had the suspicion of malingering been hastily acted upon. This rule, however, must of course only be allowed to apply to mild measures of treatment. Malingerers of a certain class, especially hysterical women, will often submit with eagerness to most painful measures of treatment, or even to those which entail permanent deformity. In all such the surgeon's duty to withstand the importunity of his patient is clear. A man is at present in one of the surgical wards who has had his forearm amputated for injury. He now complains of a painful stump, and avers that the pain is such as to wholly prevent his rest night and day. He is most desirous that another amputation should be performed. He is, however, about to be dismissed, in the belief that he is intentionally exaggerating his symptoms. The following reasons support this view :— 1. He has not the slightest aspect of suffering, or of want of rest. 2. He complains of pain in the muscles of the part removed, not in the skin, and whenever his stump is examined he always puts the remaining portions of muscle below the elbow into constant action, alternately relaxing and contracting them in a manner which can be no other than voluntary. 3. He has never on any occasion given a correct guess as to the distribution of any one of the sensory nerves of the forearm, but is obliged to refer the pain to the 'whole hand and wrist.' It is improbable that the median, radial, and ulnar, should all be neuralgic at the same time.

"His case, however, confirms the remark that most forms of malingering are based upon some real loss, and often upon some real disease still in existence. They are intentional exaggerations, rather than fictions pure and simple."

We therefore refer you to the works of Gavin Milroy, and Dr. Hutchinson on "Feigned Diseases and Malingering," only briefly alluding to some cases which offer a little special difficulty.

Feigned insanity has been spoken of at p. 867, &c.

Feigned epilepsy is sometimes difficult to detect, because *real* epileptics offer considerable varieties in the character of their seizures; one attack being a mere momentary loss of consciousness (*le petit mal*), whilst another may afford the most violent, grotesque, and prolonged convulsions (*le grand mal*). It is true that no single fit or paroxysm may last for more than a few seconds, or at most a couple of minutes or so, but they sometimes succeed each other so rapidly that the intervals are scarcely perceptible, and then seizures may be prolonged in this way for hours, and even days. The convulsions may begin and be confined to one limb [an arm or leg], or one side of the body, or may involve the head, trunk, and all the extremities. Impostors, however, usually feign the severe typical form, with the peculiar cry, falling down, struggling, lividity (done by holding their breath), and frothing at the mouth [effected by soap or some saponaceous root in the mouth], &c. They often omit to feign any of the sequelæ of true epilepsy, and may sometimes be detected by this and the fact that their pulse, respirations, &c., are little affected by their exertions—in other words, they are not much the worse for them. Many such cases have been unmasked by threats. or by *quietly* bringing something sharp or hot in contact with some part of the body. Calmeil is said to have unmasked one man, who fell into a [pretended] fit on a heap of straw in the street, by giving orders for the straw to be fired! But the most experienced directors of asylums, and hospital physicians, have sometimes been deceived by clever simulators. In lieu of giving a long table of distinctions between true and false epilepsy, it seems better to give you, from Trousseau and others. some of the characters of true epileptic seizures, italicising those which are the most difficult or impossible to feign. We may, however, note that those who feign these attacks generally take good care not to hurt themselves, and to fall conveniently; whilst genuine epileptics often injure themselves severely.

The true epileptic usually falls forwards, and thus injures his nose. forehead, chin, or cheeks, in a great majority of instances. *As he falls the true epileptic is not red, but pale—deadly pale.* Convulsions begin immediately, and are at first tonic. *The muscular rigidity is not to be overcome*, or *only with great difficulty. Once overcome, the muscles remain flaccid until some time after, or until another fit sets in. The trunk muscles are nearly always affected as well as the others.* The face only reddens after a time, and then the veins of the neck swell, &c. Then clonic convulsions set in. The tongue may or may not be bitten, and frothing is not always present. But *the pupils are dilated, and refuse to contract under the stimulus of the strongest light.*[*] The sense of smell is also abolished, and strong liquid ammonia may be held to the nose with impunity. In the very height of the convulsion, the globe of the eye, even the cornea, and other sensitive parts, may be touched without giving pain [*see* footnote]. In severe cases, the torpor, drowsiness, and confusion of mind, last for some hours, and the patient is left very weak. Occasionally there is paralysis of one half of the body. If the thumbs of the malingerer be forcibly unbent, he generally closes them again instantly; unlike the true epileptic, in whom they remain open for a while when thus unbent.

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[*] Romberg ["Manual of Nervous Diseases" translated by Dr. Sieveking] states. that he knows no sign so trustworthy as this state of the pupil. At the same time

True epileptics usually have an *aura*, or warning of some kind. Their temper is usually worse, and their irritability greater, just before the attack. Urine and fæces, or at least the former, and very often semen or prostatic fluid are discharged during the fit. Fits occurring in the night may thus be a cause of *enuresis.* After a fit numerous small punctiform ecchymoses or extravasations of blood may be found on the back or shoulders. *Bruises* and other injuries will also frequently be met with. Those who have repeated epileptic seizures at short intervals generally acquire a cast of countenance known as the *facies epileptica*, which is difficult to describe, but can best be learnt in the epileptic wards of an asylum, or in hospitals or wards for epileptics. As the question has been raised (in a trial about life insurance), *Whether it is possible for a physician to discover proofs of epilepsy*, in the intervals, in other words, to diagnose it, *from the appearance of the patient ?* the answer must be, that in not a few cases, especially when the fits are at long intervals, it is not possible to do so.

Recurring to impostors, it is to be noted that they usually, as in insanity, *over act* their part. Their contortions are too violent, and they mix up the stages of the complaint, usually disregarding the *sequelæ. Chorea*, hysteria, and other convulsive neuroses—even tetanus may be feigned. It is to be noted that genuine cases almost always come on gradually. *Chorea* is often associated with valvular disease of the heart. It must be noted here that it is sometimes very difficult to distinguish *tetanus* arising naturally from that produced by *poisons,* such as *strychnia* [See *Nux Vomica, &c.*, pp. 55 and 329].

The temperature is raised in a large number of neuroses. Even in hysteria the two sides of the body are often unequal in warmth.

Paralysis is often feigned. *Hemiplegia*, *paraplegia*, and *partial paralysis*, may one or all be assumed. Our limits forbid us to give any extended rules for the detection of these impostures. The following characters will be met with in most genuine cases of paralysis, whether spinal or cerebral—:

1. The *temperature of the paralysed limbs nearly always differs from that of the sound ones.* It is generally lower in cerebral cases (after apoplexy, &c.), and in some spinal ones. There are, however, cases of spinal paralysis, especially after injury of the cervical vertebræ, in which the temperature is greatly raised.

2. *Paralysed limbs are generally wasted.* Hence their measurement is less compared with the sound ones. This remark applies particularly to the *muscles.* The lower limbs in paraplegia often seem exceptions to this

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he warns us that reflex irritability may be present, and thus the eyelids may wink when touched with a feather, &c.

rule, but their size (which is sometimes increased) is due either t œdema, or to fat, or increased connective tissue, and not to the muscles In pseudo-hypertrophic paralysis the muscles are enlarged, but this i due to a species of degeneration.

3. *Their electrical contractility is generally lost,* or at least altered. I stating the results of trials it is well to mention the kind of apparatus used, as it sometimes happens that muscles will respond to Faradisation and not to other forms, and *vice versâ.* Electrical contractility is (as rule) entirely lost in lead poisoning, in paralysis of the portio dura, an not in the facial paralysis met with in the usual forms of (cerebral hemiplegia, nor in musculo-spiral paralysis (Panas' and Duchenne's Paralysis). The number of cells should be noted in the case of the constant current.

4. *Sensation is more or less impaired in paralysed limbs.* Dr. Hughlings Jackson has shown that in the ordinary form of hemiplegia, a hai drawn across the skin of the paralysed side can be felt. This, however does not show that tactile sensation is as good as on the opposite side Indeed it seldom is so. In traumatic injuries to nerves sensation i sometimes completely lost (anæsthesia), whilst in spinal cases, sensatio whilst lost or impaired on one side, may be increased or exalte (hyperæsthesia) on the opposite side.*

5. The *nutrition* of the muscles and other parts, such as the skin an nails, is affected and impaired. *The muscles are either flabby, or contracted hard, and shrunken,* so that the fingers or toes, &c., are usually either forcibly flexed or extended; or limp, flaccid, and powerless. The nail are brittle, and porous or pitted, or thickened like callosities; and th skin is either very smooth, or shrivelled and dusky.

6. *The mobility of the limbs is impaired,* and in some cases that of th trunk-muscles. *Reflex movements may, however, continue in their integrity* This is especially so in spinal cases—particularly in paraplegia. Surgeon sometimes forget this, and because a man's muscles contract when th skin is tickled, or because the legs "move of themselves," as the phras is, suspect the man to be malingering.

7. *Occasionally there are peculiar eruptions,* or *vesications and ulcer* in paralysed parts—all evidencing either implication of the nerves o impaired nutrition. [Bed sores are often due to this.]

Severe pain may be felt in the paralysed limbs, even when ordinary sensibility is lost. [On these subjects, besides the ordinary text-books Trousseau's and Jaccoud's "Clinical Lectures," Dr. Hughlings Jackson's Papers in the "London Hospital Reports," and Medical Journals of th last twelve years; Dr. Ogle's Papers in the "Brit. and Foreign Med Chir. Review;" the works of Dr. Buzzard, Dr. Broadbent, Dr. Radcliffe and Dr. Russell Reynolds, and especially of Duchenne of Boulogne, an the works on Medical Electricity of the latter, and of Tibbits and Vivia Poore, should be consulted]. If, therefore, we find a limb which is sai to be paralysed, of the same size, firmness, tonicity, warmth, and electri contractility as the sound one, we may be pretty sure that the paralysis is assumed or ideal. In spinal paralysis there will usually be othe symptoms, such as affections of the sphincters, &c., present.

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* An instrument with the grand name of æsthesiometer is sometimes employed A pair of compasses, with moderately fine points, or even a couple of pins and foot rule, or measure-tape, will serve as well.

This seems to be the place to make some remarks on what is called *shock to the spinal cord* as the result of railway and other accidents. In such cases the tendency of the courts, and especially of juries, some few years ago, was to overestimate the injuries, and to give undue damages against the Railway Companies, &c. Whereas now, the fashion has changed, and it has become common to sneer at all injuries to the nervous system, except such as produce, almost immediately, the coarsest and most visible lesions. Both extremes seem to the authors equally unwise and unjust. The latter, however, entails most hardships. The late Charles Dickens was never the same man after the railway accident which he described, and from which at the time he seemed to suffer little. The plaintiff, in another disputed case, a member of a large and well-known firm of electro-gilders, also suffered but slightly at first, yet his misfortunes culminated in complete paralysis and death. Even in the case of those who have shammed injuries, it has more than once happened that they, not long after, died of aneurism, which may reasonably be supposed to have dated from the collision. But, whatever weight either the doctor or the court and jury may attach to *personal statements*, it is, we think, a safe rule for medical men to follow, in giving evidence or signing certificates in such cases, to *refuse to certify or give evidence as to the specific case unless some physical facts*, [or in other words, some symptoms cognizable by the senses], *can be adduced in support of the complainant's statements.* Amongst such physical facts, in addition to what has been said above about paralysed limbs, we may have—

1. Paralysis or other affections of the cranial nerves, and hence,
2. Affections of the special senses, especially of sight and hearing [use ophthalmoscope, prisms, &c., and watch or tuning-fork].
3. Vaso-motor paralyses—such as unilateral or localised sweatings and flushings—irregular distribution of temperature, &c., &c.
4. The *pulse is nearly always affected.* In all the genuine railway cases we have seen, the pulse has been *quickened*—even long after the accident [100 or more]. It is easily to be understood, however, that it might be *slowed* in some cases, and *irregular* and *intermittent* in others, whether fast or slow.
5. Certain neuroses may be developed—choreaic movements, locomotor ataxy, hysterical and epileptiform fits—tremors, &c.
6. The speech and hand-writing may be affected. [Care should be taken in testing these, that your object is not suspected.]
7. The character and conduct may be changed.
8. Digestion and nutrition may be disturbed—hence there may be wasting, constipation, &c.
9. Sleeplessness may be induced.
10. In some cases the urine may be affected. [Sugar, phosphates, and albumen, with blood, are most probable.] See, on this subject, the note to page 277.
11. The colour of the hair may be changed, as remarked under Personal Identity.
12. More rarely, abscesses, aneurisms, and cancerous or other tumours may be developed or favoured by the shock of the collision. Fractures are, of course, too obvious to be likely to escape observation.

In speaking of neuroses, medical men often use words ending in *form* or *oid*, such as epilepti*form*, epilep*toid*, chorei*form*, and the like.

Although such expressions almost carry their own meaning, it may be as well to explain that they are generally used when the symptoms in a given case, though presenting close resemblances, differ from the typical forms of disease described in text books.

Catalepsy may undoubtedly be feigned by a very clever and courageous criminal. It is not very difficult to distinguish it from death by the tests given in chapter II. But the genuine disease is so rare that not one medical man in a thousand has seen it—and ecstatic states like those of Louise Lateau leave some doubts in the mind of clever observers like the late Dr. Day [who believed in the genuineness of that example] and Virchow [who considers L. L. an impostor, or at best a self-deceived hysterio-maniac].

Lead Palsy is accompanied with a blue line on the gums—this line is dotted, and consists of cubical crystals of lead-sulphide in the capillary loops.

True *deaf-dumbness* only occurs in *congenital* cases. The Abbé Sicard is said to have detected one impostor by noticing that his spelling of written words was phonetic. He wrote "*Ma mer et né en Nautriche,*" and "*Jean porte en core les marque.*" *

The further tests applied to this man may be seen in Beck's "Medical Jurisprudence," p. 25.

As regards *diseases of the eye, and pretended loss or imperfection of vision*, often feigned by unwilling recruits, and others, it is to be remarked that a thorough knowledge of Ophthalmic Medicine and Surgery, and some acquaintance with Optics, are necessary to detect some of these clever impostors. If simulation be suspected, *examine the eyes as you would in cases of real disease or imperfection.* The ophthalmoscope will reveal most of the morbid changes invisible to the unassisted eye, whilst the same instrument will detect all, or nearly all, the anomalies or disorders of refraction [myopia, hypermetropia, astigmatism, &c.], by the size, place, or motions of the images seen under certain conditions. It is generally necessary to paralyse the accommodation by atropine or belladonna. It will then be found that the *pretender to myopia* [or near sight] cannot see the test types at the right distances with *concave* lenses, which would suit the real sufferer. In a similar manner *convex* lenses may be used to detect *pretenders* to *hypermetropia and presbyopia* [or long sight].

Feigned double-vision may be detected in most cases by coloured glasses, and the use of prisms.†

If the pretender be himself conversant with Optics, and with the diseases feigned, it might be well to conceal the special lens, prism, or other instrument employed. A pair of spectacles made with simple or plane glasses, which neither magnify nor diminish are also useful in detecting impostors.

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* As if an Englishman wrote "Mi muthur woz bawrn in Ostreeah," and "Eye karree thee marx ov it stil."

† Dr. William Thompson (applying a discovery first made by Scheiner) has shown that anomalies of refraction in the eye may be discovered and measured by means of a couple of small holes in a card, or disc (5 mm. in diameter, say, and 4 mm. apart). "American Journal of Medical Science," January and October, 1870; "Transactions of American Ophthalmic Society," 1870; "New Sydenham Society's Biennial Retrospect," 1869-1870. Most paralytic affections of the muscles of the eyeball are attended with double vision. The following table shows the direction of the images, when the left eye is affected, and a coloured glass is placed before it. The so-called false image will be the coloured one. If there are two or

The most difficult thing to disprove is when the pretender asserts that he cannot see at all, for although it is a very rare thing, there are undoubtedly some cases, probably only temporary, in which there is real loss of sight without the most skilful oculist being able to discern anything wrong, even with the Ophthalmoscope. Such cases are, however, exceedingly rare, and in general if we examine the interior as well as the exterior of the eye, and discover no morbid change, whilst at the same time the movements of the eyeball are perfect, and the pupils act well, we may safely assert that the existence of blindness is in the highest degree improbable, although we may not assert that it is impossible. We must not, however, in testing the pupil, forget that long after vision is lost or impaired, the pupil of the defective eye may move in consonance or harmony with that of the other (healthy) eye, in certain associated movements. The pupils must therefore be examined separately, as well as together. For the benefit of those who do not pretend to medical knowledge, it may be properly recorded here, that in certain forms of blindness (commonly called amaurosis) such as that from which the poet Milton suffered, the eye looks as bright and beautiful as before, although vision may be entirely lost. [Hence the term Gutta *serena.*]

Pretended *blindness of one eye* may often be detected by a prism placed with its base upwards or downwards before the sound eye ; the double vision produced furnishing the required proof. Also, as Javal remarks, by the simple expedient of barring the vision of the sound eye by a card or pencil, so as not to appear to hide the objects, and then asking the pretender to read, or explain certain marks.

We must refer you to works on the diseases of the eye, such as those

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three muscles paralysed together, it may happen that there is only single vision. Many patients disregard the second image, and the two images tend to merge into one, in proportion as the patient turns his sound eye in the direction towards which the squinting eye inclines.

Muscle Paralysed.	Direction of Squint.	Direction of false image.	Remarks.
Internal Rectus.	Outwards.	Displaced to right in horizontal line. Not tilted.	Third nerve affected.
External Rectus.	Inwards.	Displacement to left in horizontal line. Not tilted.	Sixth nerve affected.
Superior Rectus.	Downwards.	Displacement upwards. Tilted to patient's right.	Third nerve affected. Elevation of pupil above horizontal line wholly by inferior oblique. Ample when pupil is directed inwards ; but when pupil directed outwards, only rotates eye on axis.
Inferior Rectus.	Upward.	Displacement downwards, and tilted to patient's left.	Third nerve. Depression of pupil by superior oblique. Ample when eye is directed inwards—a mere rotation when eye directed outwards.
Inferior Oblique.	Downward.	Upward displacement. Image tilted to left when pupil is above horizontal line.	Third nerve affected. Elevation of pupil effected by superior rectus. Ample when pupil is directed outwards—otherwise insufficient.
Superior Oblique.	Upwards.	Displacement of false image downwards. False image tilted to patient's *right.*	Fourth nerve affected. Depression of pupil effected by inferior rectus. Ample when eye is directed outwards—least ample when looking inwards.

These are given on Dr. Bristowe's authority. "P. of Med.," p. 1109. Reverse the directions for the right eye. To find *which* eye squints, if in doubt, cover the supposed healthy eye, and get the patient to walk—this is difficult or awkward with the squinting eye. Direct the eye to objects whilst the other eye is covered, &c.

of Soelberg Wells, Lawson, Macnamara, Haynes Walton, and other modern authorities.

Some cases of pretended *blindness*, as well as *feigned deafness*, may sometimes be detected by a ruse. Some startling statement may be written and shown in the one case, or *whispered* in the other, and the countenance, pulse, &c., of the supposed pretender watched all the while. In testing deafness, do not forget that shocks or vibrations may be *felt* when they can no longer be *heard*.

Pretended Pain and Tenderness.

It may be said, in general terms, that real sufferers, if intelligent people, can generally describe accurately the direction of pains, and these will correspond to definite nerve-tracts in most cases. [The doctor should therefore know his nerves !] Very rarely pains are diffused over very wide surfaces. Pain usually furrows the face, causes loss of sleep, and wasting (loss of body-weight), feverishness, indigestion, and other symptoms well known to medical men, if the pain lasts for any length of time. What are called *neuralgias* [pain in certain nerve-tracts—generally in the hysterical or highly nervous descendants of gouty or arthritic parents] occasionally offer exceptions to this rule, particularly in young women. A parallel is afforded by the hæmorrhages occurring in similar cases. Real pains, too, for the most part, are relieved, if not cured, by the appropriate anodynes. Long continued or very severe pain, is nearly always accompanied by other and well-marked symptoms of disease, which can be measured by instruments of precision. [Thus the pulse is affected—and very often the temperature.] Pressure nearly always *increases* tenderness, except in the case of colic, and of some forms of pleurisy, &c. Even in neuralgias, when there may be no loss of flesh, appetite, or sleep, it is usual to find some definite spots of tenderness—(often nerve-exits or nerve-divisions) well known to practical physicians —but, perhaps, inadvisable to name here, for obvious reasons.

Of other Feigned Diseases, such as Cancer.

(*Starvation* will be treated of in a separate chapter.)

Cancer has been said to be imitated (in the breast) by a piece of an animal's spleen or liver, covered with gold-beater's skin ! ! *Prolapsus ani* by a piece of gut introduced. *Bladder* disease, we have known feigned by a woman pretending to pass, *per urethram*, a pig's bladder, previously macerated. *Hydatids* of the womb, &c., have been simulated by white currants, mistletoe berries, or artificial imitations made from the intestines of animals. An experienced surgeon would almost instantly detect such impostures. *Œdema* may be produced by ligatures. We have known pretenders so overdo their parts as to bring on gangrene in the arm or leg !

Diarrhœa and dysentery have been simulated by taking strong cathartics, or by mixing urine with fæces, and so on to the end of the chapter—including pricking the gums to simulate *scurvy*, and staining the skin to imitate *jaundice !* The treatises already referred to may be consulted, as well as the systematic works of Zacchias, Paré, Beck and Guy, Foderé, Christison, Paris, Cheyne, Larrey, and Scott. If the young medical man should be called on to deal with a doubtful case, he will do well, if he cannot make the supposed impostor reveal himself, to suspend his judgment for a while, to compare the symptoms with those of real cases—and whilst sternly refusing the sanctions of legitimate medicine to the wiles of the pretender, not to forget the infinite variety of Nature, and the almost protean character of not a few even common diseases.

CHAPTER XXVIII.

Death by Apnœa [privation of air] and other allied conditions—Drowning, and Immersion after death from other causes—Hanging—Strangulation—Suffocation—Death by poisonous gases, and from Anæsthetics.—The effects of impure Air and impure Water.

MONS. TARDIEU and some English authorities object to these various modes of death being classed together. They attach more importance to the differences than to the communities of these conditions, and it cannot be denied that nearly all of them have something distinctive which warrants the separate treatment of each. On the other hand, the points of resemblance are many and striking, and there is a practical convenience in first impressing these on the student's mind, and then commenting on the special circumstances of each fatal ending. The usual mode of death in all, *death by apnœa,* commonly called *asphyxia,* has been briefly mentioned at p. 635. That account must, however, be amplified here. In this form we have, before life is extinct, *lividity* of the lips, fingers, and other extremities, and, in general, of the whole face, and other visible parts of the body; * there are *convulsive* movements which are at first more or less voluntary, though still instinctive or reflex, struggles to breathe or to save life; and afterwards involuntary and unconscious spasmodic clonic movements of muscles and limbs, which are probably due to the stimulus of venous blood [poisoned with CO_2] on the motor centres of the brain and spinal cord. The veins become turgid, the pulse is at first full and compressible, but gradually becomes more feeble; there may be, and often is, frothing at the mouth; this froth may be tinged more or less deeply with blood; blood may escape from the nostrils, anus, vagina, or other mucous membranes; urine, fæces and semen may be discharged involuntarily. Abortive efforts at respiration are made for a while. Finally these cease, and the heart no longer beats. This kind of death is more or less rapid. From two to five minutes is the usual time. In the case of drowning apparent exceptions are explicable by the occurrence of syncope. We shall return to this subject again. At the post-mortem examination we shall find in all of these deaths—

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* Consciousness soon becomes lost, although in an early stage all the faculties and senses may be unusually acute, and memory almost incredibly active, so that the events of a lifetime seem crowded into a moment, yet this stage only lasts for a very short while. This is the experience of all who have been partially drowned, or suffocated in other ways, and of those who take laughing-gas and anæsthetics. The struggles mentioned above, and the efforts to prolong life, leave their mark, and Shakespeare, with his usual felicity of expression, has condensed it all into a few lines:—

> "But see, his face is black and full of blood;
> His eyeballs further out than when he lived,
> Staring full ghastly like a strangled man;
> His hair upreared; his nostrils stretched with struggling;
> His hands abroad displayed, as one that grasped
> And tugged for life, and was by strength subdued."

When, however, the suffocation is more gradual, or syncope takes place, the features may be quite placid. This is often the case in young infants suffocated, and in the case of persons drowned.

(1) More or less *lividity* of the lips, extremities, and general surface, as has been described in life. In drowning the face is often pale—sometimes it is so in hanging.

(2) *Hypostases* or *post-mortem stainings* of darker colour than in some other forms of death. [In some cases of drowning these are not visible externally, for reasons which will appear subsequently.]

(3) The *venous system* (veins and sinuses) all over the body will generally be found gorged with blood of dark colour. The arteries will for the most part be empty, particularly in young subjects.

(4) *The right side of the heart* will generally be found full, corresponding with the venous hyperæmia and the state of the lungs about to be described.

(5) *The lungs will be found gorged with blood* in most cases, resembling the condition known as red hepatization. Only the blood is of darker colour. The mucous membrane of the bronchial tubes will be found intensely injected with extravasations of blood (see No. 6), and the tubes themselves will be found full of frothy, bloody mucus. *In young and healthy subjects, particularly children, it will often be found that the blood-vessels of the lungs have emptied themselves, after the heart has ceased to beat. The lungs will therefore in such cases be comparatively bloodless*, but from the violent efforts made to breathe *will be highly emphysematous.*

(6) *Extravasations of blood*, some minute and stellate, others of irregular form, and many of bright colour, will be found on the mucous and serous membranes [pleuræ, pericardium, peritoneum, membranes of brain, and lining membranes of its ventricles, the conjunctivæ and the mucous membranes of the respiratory, digestive, and genito-urinary tracts]. M. Tardieu attributes great importance to these in cases of infanticide, as he believes them to be present only in cases of suffocation [see page 687 for reference].

(7) The *membranes of the brain*, particularly its veins and sinuses, will be found gorged with blood in most cases, and numerous puncta cruenta or bloody spots appear on slicing the brain.

(8) *Serum is extravasated* into serous cavities [pericardium, pleuræ, peritoneum, ventricles of brain, &c.]

(9) *The mucous membranes generally are very turgid.* [*See* above, No. 6.] The trachea and larynx especially so.

(10) *Rigor mortis is said to set in slowly.* But the muscles become tetanized, and remain fixed in that condition. In hanging and other violent deaths the genital organs are often turgid and erect, so that we get priapism in the male, and an analogous condition in the female. In drowning, the penis is retracted and the scrotum shrunk, unless distended with gases from putrefaction. The bladder is sometimes filled with blood-stained urine. Sometimes the urine, fæces, and semen or prostatic fluid are discharged.

(11) The solid viscera (liver, spleen, kidneys, &c.) will generally be found enlarged and congested with dark venous blood.

(12) The blood itself will be found unusually dark in colour, containing less oxygen and more carbonic acid—sometimes carbonic oxide also

is present. The blood is also unusually fluid. If carbon monoxide be present in quantity, as from burning charcoal, the blood will be found of a bright colour, and so will be congested organs, such as the lungs. In dealing with the various forms of death by asphyxia or apnœa, we shall see each possesses special characters of its own. In death by drowning and in death by hanging, we occasionally find the same post-mortem results as in death by syncope. The heart may fail and fainting occur in the first moments of submersion, or suspension, and thus nearly all the phenomena are changed. We shall deal first with the subject of

Death by Drowning.

We have here, in most cases, two distinct sets of phenomena, viz., those due to suffocation (rarely to syncope or other causes, as mentioned above), and those due to prolonged immersion or submersion in the water. The practical questions which are likely to arise from this subject are :—

1st. Has death resulted from drowning?
2nd. How long has the body been in the water?

Some general considerations on this mode of death may reasonably precede more minute details. When a man, woman, or child, falls into the water, or is thrown into it, he or she usually makes some effort or struggles to save him or herself. If he be a swimmer these efforts are intelligent, but he may, especially in rough water, when embarrassed by high wind, a strong current, or heavy waves, particularly if in darkness or in cold stormy weather, soon be exhausted. Or he may be seized by cramp, which, so to speak, tetanizes his muscles, and this spasm may extend to the muscles of respiration, and even to the heart itself. Or fear, particularly if the dread of sharks or of some specially dangerous spot be superadded, may induce syncope.

"When a man falls or is thrown into the water, he soon sinks to a greater or less depth, but almost immediately rises to the surface again; and if he is a swimmer, makes efforts to save himself, till at length he is reduced to the condition of one who cannot swim at all, with this difference, that he has already exhausted the strength which the other has in reserve for the death-struggles common to both. These struggles consist of irregular movements of the arms and legs, and graspings of the hands at all objects within reach, whether floating in the water, fixed at the bottom, or growing on the banks. In the course of these irregular movements, he rises repeatedly to the surface,* tries to breathe, and takes in air and water. The contact of the water with the windpipe causes a cough, by which part of the fluid is rejected, and with it some air from the lungs. This occurs again and again, till the body no longer rises to the surface; water alone is received in the vain efforts to respire, while forcible involuntary expirations continue to expel the air from the chest. At length all these efforts cease, the body sinks to the bottom, and bubbles of air are forced from the chest by the elastic reaction of its parietes. The greater part of the water which has entered the mouth finds its way into the stomach, the rest into the lungs; and this residue, mixed with the secretions of the mouth and air-passages, and frothed by the air inspired and expired, forms the foam so constantly met with in persons who have perished in this way. In cases belonging to this class, we may expect to find the appearances proper to death by apnœa coupled with those of the medium in which the death takes place. In the case of the swimmer death may take place by exhaustion, with less distinct signs of death by apnœa." [This excellent description is taken verbatim from Dr. Guy, with the exception of the note.]

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* It is popularly supposed that a drowning man rises three times. The Authors can state from observation that this number is often exceeded, and sometimes (as in cases of shock or syncope) the sufferer only rises once, or at most twice.

The mode of death may vary owing to drunkenness; or from striking the head against a rock, or post, or stone, or even against the water or mud at the bottom, which may cause fracture of the skull and concussion, or the blow may be felt in the chest or at the pit of the stomach, or some other part of the abdomen, when death may be due to shock;—or there may be fright, as in hysteria, when death may result from syncope;—or an epileptic fit may happen at the moment of striking the water;—or there may be extravasation of blood or serum during the struggles, producing apoplexy;—or death may happen from the heart, owing to the cold;—or from spasm or paralysis of the muscles of respiration. It is even said that catalepsy may occur at the moment of immersion. Reviewing these causes and modes of death, we see that besides *Apnœa*, or death beginning at the lungs, we may get *coma* or death beginning at the head; and *syncope or asthenia* or death beginning at the heart; which last, indeed, is generally to be referred back to the brain: *see* page 663. Further, owing to the suspension of the heart's action in some cases both of fright and drunkenness, persons may be drowned, or completely immersed in the water, and yet not dead. We must remind you that the specific gravity of sea water is about 1·028 at 60° F. (15·5° C.). Distilled or rain water being 1·, and river, well, and pond water varying between these two in proportion to the amount of saline constituents, probably seldom exceeding 1·005, except in the case of strong mineral springs. Ice is said to have a specific gravity of 0·9175, water in freezing, expanding by about $\frac{1}{11}$th of its volume. *The human body, on the other hand, has a specific gravity slightly greater than that of water.* Dr. Taylor's remarks on this subject deserve quoting. He says: "The specific gravity of the human body in the *living* healthy state is made up of the combined specific gravities of its different parts, so that as in all heterogeneous solids, it is a very complex quantity. In the first place about 72 per cent. of the weight of the body consists entirely of water, hence the question of specific gravity can refer only to the remaining 28 per cent. of dry solids. The only part of the body which is lighter than water is fat. The specific gravity of this is 0·92, and it is calculated that the proportion of fat in an adult is about 5 per cent. or one twentieth part of the weight of the body. The specific gravity of muscle is 1·085, of brain 1·04, of the soft organs generally 1·05, of the lungs containing air 0·94, and of bone the heaviest part of the body 2·01. The lightness of the fatty portions is more than counterbalanced by the weight of the skeleton (about 10½lbs. in the male, and 9lbs. in the female), *so that the naked human body, placed on water, has a slight tendency to sink.* This tendency diminishes just in proportion to the quantity of the body immersed, because all those parts which are out of water, not being supported by water, become so much additional absolute weight to the portion immersed. Hence the frequent cause of death by drowning. An inexperienced person exhausts himself by exertion, raises his arms continually out of the water, and as often sinks, owing to their weight having just so much effect on his body as if a leaden weight had been suddenly applied to his feet to sink him. When the *whole* of the living body is immersed, the specific gravity, owing to the expansion of the chest, differs so little from that of water, that a very slight motion of the hands or feet will suffice to keep a person on the surface. The head, owing to the weight of the bones of the skull, has always a tendency to sink below the level of water." As *corollaries* to this statement, it may be said that *fat people float best, women,* as a rule, *better than men* (a woman, too, is often buoyed up by her clothes at first*)—*infants and young children, when fat, better than women—bony persons and very lean persons float worst of all, or not at all.* Persons with large chests float well, on account of the air in the lungs, and the lightness of the contained viscera. *Sometimes bodies do not sink at all in sea-water.* Of this Dr. Taylor records an instance, the specific gravity being presumably about the same as that of the water (1·026 or 1·027). Dr. Taylor takes the average specific gravity of the *dead* body to be 1·080 to 1·100, and hence a very little gas (from putrefaction) will suffice to keep it at or near the surface. Weights are attached to dead bodies "buried at sea," as it is called, to prevent their floating from putrefaction in this way.

Cork being specifically so much lighter than water [specific gravity about 0·240], a very small quantity is required to sustain a man in the water. It is calculated that 12lbs. of cork cut in slices, properly arranged, and covered with painted canvas, would sustain six persons, each of ten stone, or making allowance for clothes, at least four persons. From three to four pounds of cork may thus be considered sufficient to float one person; but allowing for all possible contingencies, as extreme density, it would be better to allow 6 or 7 lbs. It must be so arranged, under the armpits, as not to impede respiration or the use of the arms. Inflated india-rubber is often used instead. Considering the mistakes made in these subjects, it seems necessary to give here precise instructions as to the

Treatment of Persons taken out of the Water.

The first question which will naturally occur to you is, How long after submersion is it possible for life to be restored? We need scarcely say, that if there were manifest signs of putrefaction you would only cover yourselves with ridicule by endeavouring to restore animation. Do not, however, mistake the mark of a bruise for this. Putrefied bodies will be found floating. This seldom occurs in bodies perfectly fresh, yet instances are known. [See last page.] The experiments of the Committee of the Medico-Chirurgical Society [see their "Transactions," vol. xlv.] show that in animals suffocated the respiratory movements ceased in about five minutes, the heart continuing to beat for some three or four minutes longer. Adding these together we get about eight or nine minutes as the longest period after which dogs and other animals experimented upon could be revived again. After complete submersion about two minutes was the longest period. This was probably due to the entrance of water into the lungs. In the human being, however, a somewhat longer period may elapse, although divers cannot bear more than from a minute and a half to two minutes entire submersion, yet Dr. Wooley (for many years medical officer to the Royal Humane Society) met with two cases of recovery after five minutes' submersion. In the "Lancet," July, 1841, and "Medical Gazette" (vol. xxix. p. 78), instances of ten and thirteen minutes respectively are recorded. Dr. Taylor quotes from the same journal, p. 448, a case of fourteen minutes, and from the "American Journal of Medical Sciences," April 22, 1853, p. 348, the recovery of a woman after twenty minutes' submersion. M. Guérard quotes a case in which a young man is said to have recovered after entire submersion for an hour. The case is said to have occurred in 1774, but the evidence as to time is rather weak. ["Ann. d'Hygiène," 1850-2, p. 306.] It is very likely, that in these cases, as in some known to the Authors, the whole of the body, especially the face, was not under water. Even in the longer authentic periods of a quarter or half an hour, syncope had probably occurred. Yet, as the circumstances of the case are often uncertain as to time, it may be well to try to restore animation in any case where the body is taken out of the water within a few hours of the accident, or when it is perfectly fresh.* The Authors know, from personal experience, that two or three hours' efforts may sometimes be necessary to completely restore the circulation.

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* See Shakespeare's description of Ophelia's death.

The indications for treatment are:—

(1) To restore animal heat.

(2) To stimulate the heart to action.

(3) To carry on artificial respiration, until the natural process is resumed.

(4) To rouse the nervous centres.

(5) To combat the tendency to death from inflammatory or other sequelæ.

The popular methods of hanging up by the heels, rolling on casks, and other rough processes, are to be condemned *in toto.* Treatment should be commenced at once on the spot in the open air whilst blankets and dry clothing are sent for. In order to get rid of water in the mouth, &c., the body may be placed for a *few seconds* with the head a little lower than the feet, and the head downwards, the mouth being open, and the tongue drawn forwards, then turn the body on the back, and raise the head and shoulders slightly (on a board forming an inclined plane, if possible, a door or shutter will serve very well). Draw the tongue forward, and fix it by an india-rubber band. The feet should be fixed, and then Dr. Sylvester's method of artificial respiration should be commenced. This will be best understood from the diagrams. Grasp the arms at the elbows, draw them above the head, and keep them so, on the stretch (as in Fig. 111) for about two or three seconds, then reverse the manœuvre for about the same length of time, pressing the arms firmly against the sides of the chest (as in Fig. 112). This twofold or alternate movement should be repeated about fifteen or sixteen times a minute, till a spontaneous effort at respiration occurs. Young operators are apt to make these movements rather too rapidly. Meanwhile, or at all events after a few minutes, the bystanders or assistants can remove the wet clothes, place hot bottles or tins to the feet, hot flannels over the præcordial region, or put hot bricks wrapt up in lieu of hot bottles, here, in the armpits &c.; cover the body lightly with blankets, chafe the lower extremities, &c. In some cases respiration may be promoted by smelling-salts or ammonia to the nose, tickling the throat with a feather, dashing hot and cold water on the face and chest, and galvanizing the phrenic nerve. [One pole or rheophore should be applied to the epigastrium, the other to the nape of the neck, or just above the middle of the clavicle, where the omo-hyoid crosses the sterno-mastoid muscles;—some advise both rheophores to be applied above, one on each side of the neck, and they insert needles or pins, in the hope of touching the phrenic nerves; this proceeding the Authors believe to be unnecessary.] The galvanism should not be too long continued, as it is possible to wear out the nervous irritability, and thus protracted galvanism may be dangerous, and indeed is so in some cases. Fine needles may be inserted for a moment into the heart so as to stimulate that. In some cases after signs of life are manifest, but the right heart is greatly loaded, as evidenced by the cyanotic condition, bleeding to some ounces may be indicated [case by Dr. Heckford and Dr. Woodman in "St. Andrew's Med.

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* In Paris, from 1821 to 1826, out of 576 cases of drowning, 430 were resuscitated.

FIG. 111.

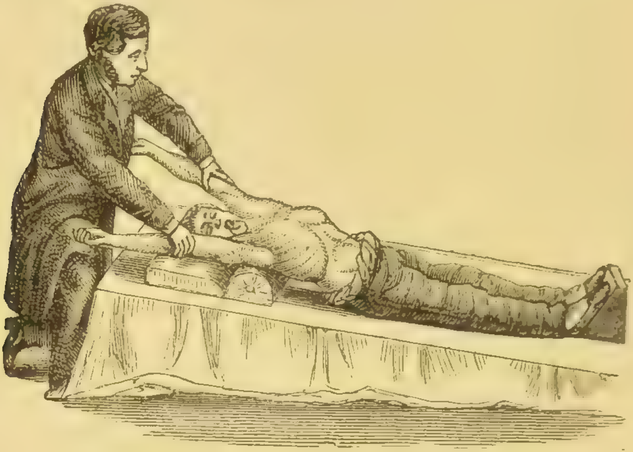
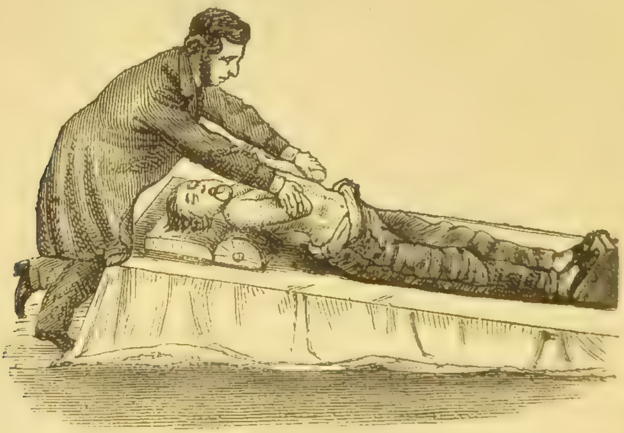


FIG. 112.



Grads, Transac.," vol. v., p. 230]. When the patient can swallow a little, a teaspoonful or two of warm brandy and water should be given. Afterwards warm beef-tea, or ordinary tea with eggs beaten up in it, or warm milk. If swallowing is difficult these may be injected into the rectum. In some cases, saline injections (at 100° Fahrenheit or 38° C.) may be made into the veins.

Other methods of artificial respiration, as by compressing the thorax, and Dr. Marshall Hall's postural method are sometimes used. The report of the Royal Medico-Chirurgical Society, previously quoted, shows them all to be inferior to Dr. Sylvester's method. Thus, the latter (as shown in our diagrams) was proved capable of introducing from 9 to 44 cubic inches of air, 20 cubic inches being an average quantity in natural respiration;—Dr. Hall's process only from at most 8 to 15 cubic inches;—and the pressure method [with 30 pounds pressure] either by hands, or by a crossed bandage only, from 5 to 10 cubic inches. Life has been saved by all these methods, but the Authors have known the gall-bladder ruptured by pressure with the hands.

When respiration is established pretty fairly, and the heart's action and warmth restored, you may safely leave the patient for a while, provided the lips and extremities are of good colour. But do not forget that there may be a relapse. Some one should therefore watch the patient. Death may ensue from pneumonia, shock, and other causes, directly due to the submersion some days, or even weeks, after the accident.

Post-mortem appearances specially due to drowning.

The special phenomena found in the dead body in this mode of death (in addition to the general signs of apnœa previously mentioned (page 919), which Devergie states occur in 25 per cent. in a well-marked manner, and in 87 per cent. in a modified form * are as follow :—

1. *Goose-skin*, or *cutis anserina*, is met with in many cases, yet is not really pathognomonic of drowning, being met with, especially in the lower classes, in other violent modes of death.

2. *A livid, greyish-blue colour of the hands and feet*, like the *cholera-hand*, or washerwoman's hand; the skin is wrinkled and corrugated as well as cyanotic. This symptom needs twelve to twenty-four hours submersion, and may occur in bodies thrown into the water after death. ["Casper," *loc. cit.*, translation, vol. ii., p. 235.]

3. *Contraction of the penis, with retraction*, so that the penis appears inordinately small, even in men of large stature.

4. *Sand, gravel, mud, &c., may be found under the finger-nails of the body.* These are not always present, but when found may be of import-

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* Devergie's figures ("Méd. Légale," vol. 2, p. 336), as given by Dr. Taylor, are as under :—

Asphyxia, pure . . .	25·0	Asphyxia .	87·5
,, and syncope .	62·5		
,, and cerebral congestion .			
Syncope, apoplexy, or concussion			12·5
			100

Dr. Ogston's results are very similar, "Med. Gazette," vol. 48, p. 291; "Med. Times and Gazette," 1876; Dr. Löffler, "Henke's Zeitschrift der S. A.," 1844, L. 1

ance. Sometimes fragments of sea or fresh water weeds may be found in the hands, as well as in the stomach and lungs. There may be diatoms, small shells, and other objects, which may help to determine the spot where the death took place. Microscopic examinations should, therefore, not be neglected.*

5. *Excoriations or abrasions of the fingers are very common.* As regards the condition of the eyes, these are sometimes wide open, "Dreadfully staring, thro' muddy impurity" [T. Hood]; sometimes half-open, and sometimes closed. The face is somewhat bloated, often pale, somewhat resembling the condition common in chronic Bright's disease. Martial twits Sextus with having the face of one, "sub aquá natantis" [Epig., lib. ii., No. 87], which the commentators explain as "subpallidam et tumidam." The general position of a drowned body is very well shown in the well-known picture of a Christian Martyr in the reign of Diocletian by Delaroche, though the head is a little too high out of the water.

6. Post-mortem rigidity is generally present. The post-mortem phenomena due to *putrefaction* and to prolonged *maceration* in water, including the formation of *adipocere*, have already been described at pages 23—30, and 797 to 799.

7. *In cases of homicide or suicide the hands and feet may be tied together, and weights attached to the body.* If this have taken place during life, or whilst the body is still warm, we shall find similar appearances in the marks of the ligatures to those described under hanging and strangulation, to which we must refer you. In cases of homicide (murder by drowning), there will probably be marks of other injuries—wounds, contusions; the shoulders, hips, cervical vertebræ, &c., may be dislocated; of this the Authors have seen instances from falling into the water from a height; fractures of the skull; and especially in females where rape has been attempted, injuries to the genital organs, marks of nails on the thighs, on the arms and hands, and the like. In judging as to whether these injuries were inflicted before death, or were produced by the body in falling into the water, by the keel of a passing vessel, by boat-hooks, &c., the same principles must guide you which are laid down in the chapter on wounds and violent modes of death. The nose, lips, fingers, toes, genitals, and other parts of the body, are sometimes found to have been gnawed by rats, or by voracious fishes, such as the pike, shark, &c. In general the nature of these injuries, and when inflicted, are tolerably evident on inspection.

8. *There may be froth at the mouth and nostrils,* and this may be blood-stained. Though very common, this is by no means pathognomonic of drowning.

It is to be noted that a very small quantity of water or soft mud may produce death by apnœa in feeble or intoxicated persons. Dr. Brunton, late of the Paisley Infirmary, escaping from his nurse, whilst delirious from typhoid fever, ran along the canal banks, but did not fall into the water. He met his death by falling face downwards on to soft mud of only a few inches depth on the towing-path. Such a death, however, is not properly drowning.

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* In regard to this point, it has been well said that we must not forget that Barbadoes sand, and other foreign materials, are used for ballast, and may be discharged in a home port.

Internal Appearances in Death by Drowning.

Many of the supposed signs of drowning—such as great coldness of the body, the position of the epiglottis, and the position of the diaphragm—are simply valueless. Kanzler's experiments, showing the epiglottis to be always upright, were performed on animals, but even in these this rule is by no means invariable, still less so in human beings. The position of the diaphragm is partly determined by putrefaction, partly by the exact mode of death. Whilst, as stated above, the lungs, right heart, and brain, the pulmonary arteries and the venous system, with the solid viscera, are usually found congested with dark fluid blood (page 919), this is by no means invariably so. Death may take place by syncope, asthenia, shock, concussion, or in some way combining one or more of these, as in what Casper calls death by neuro-paralysis, and then either both sides of the heart are partly filled, or both empty and flaccid, or the left side is distended even more than the right. Dr. Ogston found the right cavities of the heart empty in one or two cases out of fifty-eight, whilst the left were empty in fourteen ("Med. Gaz.," vol. xlviii., p. 291). Riedell (quoted by Taylor) states that the two sides of the heart contained equal quantities of blood in half the cases actually seen by him, whilst in the other half the right cavities contained most. In only one case did he find the left quite empty. It does not appear that the *brain* is usually very hyperæmic. Indeed, Casper and Taylor think the reverse condition more common. On the other hand, the following symptoms are pretty constant:—

1. *Water*, or other foreign fluids *in the stomach*. Casper warns us that water may sometimes have been drank just before the drowning, as in the case of a little boy, aged two years, whose nurse had just fetched him water from a spring, left him a moment, and found him drowned in a river on her return. [Casper's 292nd case.] Kanzler and Riedell [quoted by Casper] often found this symptom absent in cats, even when the mouth was kept open or enlarged. It seems, however, to be pretty constant in the human subject. Again, it is highly improbable that very dirty water, liquid manure, or mud, would be voluntarily taken as a drink. Yet these are often found. Finding about half a teaspoonful of liquid mud in the stomach of a man, whose body had been four or five months in the water, made Casper pretty sure that death had resulted from drowning, in Case CCCXI., quoted by him. Human ordure in substance is sometimes found, particularly in cases of infanticide in privies and cesspools [Casper, *loc. cit.*; and Märklin; Casper's "Vierteljahrsschrift," 1859. Bd. xvj. s. 26]. The presence of green *confervæ*, or duck-weed, of minute shells, or diatoms, would be additional confirmation. It does not appear that much water gets into the stomach in bodies thrown into the water after death. Fluids, &c., found in the stomach, should be examined with a microscope or strong lens.

2. *Water*, or other foreign liquids, *in the lungs* and air-passages, particularly if those fluids are like those mentioned above, liquid manure, or other dirty matters, is another confirmatory proof of death from drowning. For where the lungs and air-passages are full of frothy fluid, it is generally evidence of struggles to breathe. Casper mentions one case

in which camomile-tea, which had been vomited by an adult into a pail, was thus found in the stomach of an infant. Here, again, the microscope should be used to examine the fluids and foreign bodies found. The volume of the lungs is generally increased in drowning from hyperæmia. Their condition, and that of the bronchial mucous membrane, has been described at the commencement of this chapter. Remember the lungs may sometimes be anæmic and emphysematous.

3. *The larynx and trachea*, besides containing frothy fluid, as mentioned above, *are often deeply congested.* The colour is usually cinnabar or vermilion, darker shades, as chocolate, being usually due to putrefaction. There may also be evidences of emphysema in and around the windpipe. The froth is sometimes blood-stained; it is in small, tender bubbles, which are easily broken.

4. *The fluidity of the blood*, from want of oxygenation, *and its dark colour*, though not peculiar to drowning, are scarcely ever absent, when death has taken place from this cause, and therefore deserves special mention. A few instances of coagulated blood in the heart, &c., are mentioned by Orfila and others. The tongue will probably be found pushed up against the teeth, and marked by them. In rare instances it is bitten.

Putting together these various symptoms, we may therefore advise you, that you will in general (Devergie says 99 cases out of 100) be quite justified in saying that death has taken place by drowning, when you get the following external appearances :—Skin shrivelled, bluish-gray, with goose-skin appearance (cutis anserina), with contraction of the penis in the male; excoriations on the fingers, with weeds, sand, gravel or mud in the hands, or under the nails; froth on the lips, the tongue partly protruded, or pushed against the teeth; dilated pupils; and, on *post-mortem examination*, you find water or other fluids in the stomach; frothy fluid in the lungs and air-passages, congestion of larynx and trachea; and fluid blood. If the symptoms due to asphyxia in the heart, lungs, and venous system generally are added to these, you may be nearly certain that death has happened in no other way.

If, on the other hand, you find marks of a cord round the neck (see Hanging), gun-shot wounds, stabs in vital regions, traces of poisons, the lungs in a state of collapse, and the absence of the signs just enumerated, you may reasonably conclude that the body has been thrown into water after death. In this case, in addition to putrefactive phenomena, there may be those due to imbibition. In answer to the question, *How long has the body been in the water?* we think, although his opinions have been much questioned, that M. Devergie's conclusions, formed as they were from an immense experience at the Paris *Morgue*, where all the bodies drowned in the Seine, near Paris, are taken, are more reliable than any others known to us. We shall arrange them for convenience, as under. [See "Devergie, Annales d'Hygiène," vol. ii., p. 160; and again, vol. v., p. 429; vol. vi., p. 209.]

First four or five days.—Little change. Post-mortem rigidity may persist to the fourth day in some cases, particularly if the water be cold.

Fourth or fifth day.—Skin of palms begins to whiten, particularly ball of thumb and little finger, and lateral surfaces of fingers. On the sixth or eighth day this extends to the palms of the hands, and soles of the feet; the skin of the face is softened, and of a more faded white than the rest of the body.

On the fifteenth day.—The face is slightly swollen and red; a greenish spot begins to form on the skin of the mid-sternum; the hands and feet are quite white, except the dorsum of latter; the skin of the palms is wrinkled; the sub-cutaneous cellular tissue of the thorax is reddish, and the upper part of the cortical substance of the brain greenish.

At one month.—The face is reddish brown, the eyelids and lips green and swollen, the neck slightly green; a brown spot, with green areola, about six inches in diameter, occupies the upper and middle part of sternum. Skin very wrinkled; hair and nails are still adherent. The scrotum and penis are now much distended by gas, so that the latter is sometimes erect from this cause. The lungs become very emphysematous, and overlap the heart.

At about six or seven weeks.—The neck and thorax are very green, and the cuticle at the base of the hands (wrists) begins to detach itself.

At two months.—The body is covered with slime, which penetrates through the clothes; the face is enormously swelled, and brown; the swollen lips parted, so as to expose the teeth. The skin on the middle of the abdomen, as well as that of the arms, forearms, thighs, and legs, is still in a natural state; thus contrasting with the phenomena of putrefaction in air, when the abdomen is the first part to exhibit change. Now the skin, with the nails attached, begins to come off, like a glove, from the hands and feet; the hair falls off, or can easily be detached by pulling; the veins are almost completely empty of blood, and filled with gas. If at the moment of death the right cavities of the heart were gorged with blood, the internal surface of the right ventricle is now of a jet black. Devergie insists on this.

At two and a half months.—The green colour of the skin extends to the arms, forearms, and legs; the nails are quite detached from the hands and feet. Some *adipocere* is formed on the cheeks, chin, breasts, arm-pits, and interior part of the thighs [see before, pp. 23—30]; the abdomen is greatly distended by gases from putrefaction. As yet the muscles are not much altered in colour.

At three and a half months.—The scalp, eyelids, and nose are so destroyed, as to make recognition, even of age, difficult or impossible from mere inspection. The skin of the breast is generally of a greenish brown, the centre of the abdomen of an opaline colour, and scattered with small ulcerations, caused by the water. Larger erosions are found in other parts of the body. The hands and feet are quite bare of skin; the lungs no longer fill the thorax, but leave a space between them and the pleura costalis, full of reddish serum.

At four and a half months.—The face and scalp are so destroyed, as to leave the skull bare; the remains of the face, neck, and interior parts of the thighs are entirely converted into *adipocere*; and small eminences, indicating the commencement of calcareous incrustation, are observed on the prominent parts; the brain presents traces of adipocere in its anterior part." Further than this Devergie has not classified.

These changes may proceed more rapidly in very hot weather, or in very putrid pools and ponds; more slowly in salt water, in very cold weather, and when the body is closely invested by clothing. But the general order of facts remains the same.

The only illustrative cases we shall quote are one or two, in which there were some special circumstances of unusual interest. They are mostly taken from Beck. [*Loc. cit.*, pp. 602—608.]

CASE I.—*Drowning, supposed to be Murder.—The Dead Body found floating.*

In 1699, V. Spencer Cowper, Esq., an English barrister, and three others, were tried at the Hertford Assizes for the murder of Mrs. Stout. It was alleged that there was a criminal intimacy between Mr. Cowper and Mrs. Stout. About ten p.m. both were missed by the servant from a room in which she had left them; and *next morning Mrs. Stout was found quite dead, floating on water of about five feet in depth.* Her body was about five or six inches under the water, although some of her clothes were on its surface. Mr. Dimsdale, a surgeon called in, found both sides of the neck swelled and black, and the skin between her breasts, up towards the collar-bone, also dark-coloured. The left wrist was slightly bruised. This bruise was afterwards ascribed to some stakes, which may have had their share in preventing the body from sinking, although it is likely that, Mrs. Stout being somewhat corpulent, her specific gravity did not much differ from that of the water. A little froth issued from her mouth and nostrils when first seen. No further post-mortem examination was made for six weeks, when the body was disinterred. On examining it, no water was found in lungs or stomach, and it was said to be so decomposed, that little evidence could be given as to the bruises. This trial is chiefly remarkable for the extraordinary opinions of some of the witnesses as to dead bodies floating. Most of those examined (some of whom were sailors) correctly explained the floating of dead bodies to be usually due to putrefaction. We have called attention to the fact that stout bodies do sometimes float, though this is usually in salt water. On this trial Drs. Garth, Sloane, Morley, Wollaston, and Crell, with William Cowper, the celebrated Anatomist, were all examined. Mr. V. S. Cowper deposed to a previous melancholy state of mind; and the jury brought in a verdict of *non compos mentis.* Mr. Cowper was brother of Lord Chancellor Cowper; and in after years became a Judge in the Court of Common Pleas. [Hargreave's "State Trials," vol. v., pp. 193—231; Beck, *loc. cit.*; "London Law Magazine," vol. x.]

CASES II., III., AND IV.—*Dislocations from Falls into the Water.*

"A few years ago, a man who had leaped from three of the bridges into the Thames with impunity, undertook to repeat the exploit for a wager. Having jumped from London Bridge, he sank, and was drowned. When the body was found, it appeared that he had gone down with the arms in the horizontal, instead of the perpendicular posture, in consequence of which both of them were dislocated by the fall upon the water." [Smith, p. 214: quoted by Beck.] Dr. Reveillon [Archives Générales, "Medico-Chirurg. Review," vol. xi., p. 240] mentions the case of a soldier, an excellent swimmer, who plunged headlong into the Sambre. He was seen to struggle, and was supposed to be in jest; but as he was noticed to be motionless, he was dragged out. When he recovered his senses he was found to be perfectly paralysed from the neck downwards. Death followed in a few hours; and, on dissection, the body of the fifth cervical vertebra was found fractured transversely. Guy quotes another case from South's "Chelius," vol. i., p. 532, in which the fourth cervical vertebra was fractured. The authors know of recent cases of fractures of the ribs, lower end of radius, sternum, and humerus; and of dislocated humerus and femur, apparently produced simply by falling on the water.

CASE V.—*A Body floats in thirteen days, although a heavy weight is attached to the legs.*

This was the body of Prince Carracioli, who was hung by the order of Lord Nelson. It was sunk in the sea, with double-headed shot, weighing 250 pounds, tied to the legs. [Male. 2nd Edit., p. 186.] The shot must clearly have slipped off. In general, however, bodies will float in about five to eight days. [The popular idea of three days is incorrect as a general statement.] It has been supposed that when a ligature is tied tightly round the neck, the contained air will float the body.

CASES VI. and VII.—*A Body is found in the Seine, with the feet, wrists, and neck tied.—Suicide inferred from the knots.—Another doubtful case—Suicide or Accident.*

The first case is quoted by Beck, from the "Annales d'Hygiène," vol. ix., p. 207. The body was that of the Sieur X. None of the knots were tight, and they had left little impression on the skin. On dissection the liver and heart exhibited marks of long continued disease. There were no external injuries, and the knots were slip-knots. Marc, Giuchard, and the other medical witnesses, inferred from these facts that this was a case of suicide.

In the case of *Garbet, and others, executors of Rainer* v. *the Rock Insurance Company*, a Mr. Rainer, whose life was insured in the Rock Insurance Company for £3,000 (with a special proviso against suicide), was found drowned in a pond. He was known to be insane. From the state of his shoes and stockings it was inferred that he had gone into the pond with his clothes on, had afterwards taken them off, and then returned to the pond. As he had undressed, it was argued that he meant to bathe only, not to commit suicide. Verdict for the executors. The Chief Baron remarked on the paucity of facts in this case.

In March, 1806, a young woman, at Little Sheffield, in Yorkshire, made away with herself, by breaking a hole in the ice upon a pond, and thrusting her head in, whilst the body remained out. This situation repelled the idea either of force or of accident. [Smith, p. 275, quoted by Beck.]

The case of Meecham has been quoted in connection with *adipocere*, p. 23—30; and that of Mary Ashford, at p. 743.

Dr. Taylor quotes cases of epilepsy, inducing drowning: and of apoplexy in a man, who was about to rescue a boy from drowning, only the fit came on at the moment he was going to jump.

The following cases, quoted by Dr. Taylor (*loc. cit.*, vol. ii., p. 23, &c.), also deserve study by medico-legists:—

The *Queen* v. *Longley* (C. C. C., April, 1841).

The *Queen* v. *Owen, Thomas and Ellis* (Stafford Lent Assizes, 1840).

Regina v. *Carnt* (Suffolk Lent Assizes, 1851). [Medical evidence of Mr. Image, confirmed by the confession of the murderer, though objected to at the trial.]

Regina v. *Griffin* (Shrewsbury Lent Assizes, 1861).

Regina v. *Kettlebrand* (Nottingham Winter Assizes, 1843). Luxation of odontoid process (see Hanging), and rupture of its ligaments. A verdict of "Manslaughter" against the father of the deceased, a boy who was aged only ten years.

Regina v. *Yaxley* (Norwich Lent Assizes, 1841). A woman holds an infant's *head* in a pail of water for a time, then withdraws it, and it died soon after.

Bishop and Williams killed Carlo Ferrari, in order to sell his body for dissection, by making him drunk, and hanging him up by his heels, with his head in the water of a well!

Dr. Norman Cheevers ["Medical Jurisprudence for India," 1856, p. 351] examined the body of a child, whose right air-tube was tightly crammed with a water-weed, not growing in the tank where the dead body was found. It was proved that the woman who found the body in one tank (where the weed grew) carried it, to gratify spite, to another tank in which she professed to discover it.

The works of Casper, Taylor, Guy, Norman, Cheevers, and especially Beck, are very rich in illustrations of singular and difficult cases of bodies found in the water, including accidents, suicides, and murders. Our space does not allow us to lay them further under contribution.

Death by Hanging.

As in the case of drowning, so in hanging, death does not always take place in exactly the same way. Whilst *asphyxia* or *apnœa*, death beginning at the lungs, is very common; death by *cerebral hyperæmia*, or death beginning at the brain; and a form combining these (*asphyxia with apoplexy*); death due to *syncope;* and death from injury to the *spinal cord, and vagus nerve in the neck* (neuro-paralytic death)—are also met with. According to Casper and Remer, as summarized by Dr. Taylor, the proportions are as follows:—

	Remer.	Casper.
Apoplexy	9	9
Asphyxia	6	14
Mixed Conditions . . .	68	62
Total . .	83	85

We shall again mention these conditions in speaking of the post-mortem appearances.

The practical questions arising out of this mode of death are as follows:—

1. *Did death take place by hanging* [or *suspension*]? By this term is signified "that kind of death in which the body is wholly or partially suspended by the neck" by a rope, cord, or some similar ligature; "and the constricting force is the weight of the body itself, whilst in strangulation the constricting force is due to some other cause." Observe, therefore, that neither the cord or other substance round the neck of

the dead body, nor the plainest marks of its presence, prove death to have taken place in this manner, since a body may be hanged sooner or later after death from some other cause.

Provided we are satisfied that death really took place from this cause, the next question will probably be—

2. *Was the death suicidal, or homicidal?* In other words, Did the deceased voluntarily hang him- or herself? or was he or she hanged by another, or others? Observe, that the question of capital punishment scarcely comes within the province of even the gaol-surgeon, since the sentence of the law, and the fact of its execution, will usually have to be proved by other than medical witnesses, the duties of the latter being confined to stating the post-mortem appearances, and the identity of the body.

General Considerations as to Hanging.

This mode of death is prescribed by the English law as the punishment for high-treason and murder only; though previous to the 24 and 25 Vict., Cap. xcvi.—xcviii., c., our law was very sanguinary. Blackstone, in his Commentaries (A.D. 1765), admits that 160 crimes were punishable by death by our laws. Hanging is still retained in some parts of Germany, Austria, the United States, and some other countries, as the punishment for murder, and other crimes. In France the *Guillotine;* in Spain the *Garotte*, supersedes it. Hanging is also a tolerably common means of suicide, and not unfrequently happens accidentally; young lads, and sometimes older persons of both sexes, being not infrequently foolish enough to try this horrible experiment upon themselves or their comrades. It is said to be sometimes done for erotic purposes, though it is very doubtful if any other than disagreeable sensations are felt; such as a noise and fulness in the ears, throbbing in the eyeballs, and a sensation of sparks of light, feelings of constriction in the throat, taste of blood, and perhaps a smell of blood, and struggles for breath, with perhaps a crowd of more or less confused recollections of past events, then darkness and oblivion. From one or two minutes up to half an hour may elapse before death, although usually five minutes is believed to be a near approximation to the fatal time. Dr. Haughton, of Dublin, recently read a paper before the Surgical Society of Dublin, after investigating the methods of hanging adopted by different executioners. The conclusions he arrived at are as follows:—

"1. That the old system of taking the convict's life by suffocation is inhumanly painful, unnecessarily prolonged, and revolting to the spectators, whose duty it is to be present.

2. That the object of an effective execution by suspension should be the immediate rupture of the spinal column by the fall.

3. That the use of a "long drop" (which by habit has become known as the *Irish method*) is not only much preferable from a humanitarian point of view, but is the only method by which the desired object can be effectively attained.

4. That the short fall and position of the knot employed for so many years by Calcraft are barbarisms, which should cease to be permitted.

5. That the fracture of the spinal column can best be instantaneously

effected by placing the knot under the chin, and allowing a fall of at least ten feet (ten to fourteen feet).

6. That in the carrying out of a capital sentence care should be exercised in the selection of a suitable rope."

In the recent execution of Wainwright these principles were adopted with success. In some of the executions of late years the death was often painfully protracted, and the feelings of the bystanders outraged by watching the death struggles of the poor victim. And although the *Irish method*, here advocated, is an immense gain in point of humanity and certainty, the practice in Ireland was not always so commendable. It is said that at one execution, through using too thin a rope, and too powerful a jerk, the head was actually severed from the body in one case. Death from "rupture of the spinal column," as it is called above, is said to have been first noticed as one of the modes of death in hanging by the celebrated Louis.* He found that in the cases of rapid death at executions by hanging, the executioner was in the habit of giving a violent rotatory motion to the body of the criminal at the moment it was turned off; whereby a displacement of the odontoid (or tooth-like) process of the second vertebra of the neck (axis) took place, so that the spinal cord or marrow was suddenly compressed. Dr. Taylor says, that to secure this, the body must be heavy, the fall sudden, and long; and probably considerable violence used by the executioner. Devergie found this only once in fifty-two cases. But fracture of the odontoid process is more common, according to M. de la Fosse. M. Caussé (d'Albi) remarks, in his Dissertation on the subject [" Mémoire Médico-Légale sur les Luxations des Vertébres Cervicales," Albi, 1852], that the Paris hangman, who was famous for this rapid method of death, always put the slip-knot in front, under the chin, as mentioned above by Dr. Haughton. The figure in the text will explain this point. Fig. 113 shows the *atlas*, or first cervical vertebra. The small number 1, represents the tubercle, in front of the anterior arch; 2, shows where the *odontoid process* fits [marked 2, 3, in fig. 114, the part marked 3, in the right-hand figure, being the part of the *odontoid process* of the *axis*, or second cervical vertebra, which adjoins 2, in the left-hand figure (fig. 113);] a strong *transverse ligament* stretches across in the direction of a line marked 6, 8, and completes the arch, whilst the spinal cord lies immediately behind it. The fig. 7 is the left superior articulating surface on which the left condyle of the occipital bone (of the head) rests; the right superior articulating surface is on the other side, to the right of 8: in the diagram 8 marks the attachment of the transverse

FIG. 113.

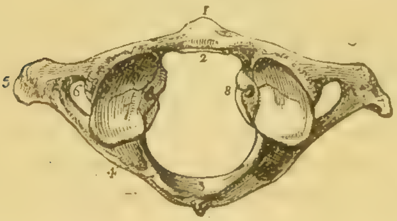
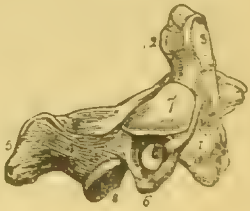


FIG. 114.



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* A. Louis. "Oeuvres Complètes," t. 1, p. 333.

ligament referred to above. In the right-hand figure (114) the surface marked 7, is the superior articulating surface of the *axis*, on which the atlas rests.

When such force is applied, as either to break the transverse and other ligaments, or to fracture the odontoid process, not only are the phrenic nerves, and other respiratory nerves likely to be paralysed, but the vertebral and carotid arteries may be ruptured, and the medulla oblongata (centre for respiration, circulation and deglutition—in fact, the *vital knot*) can scarcely escape severe and fatal injury. The position of the cord or ligature (and it would appear that a cord or rope was used in more than half the cases of hanging collected by Devergie and Casper, and portions of shirts and sheets, garters, aprons, and other articles of dress in the remaining half) may sometimes be of importance, and should always be noticed. Drs. Tardieu and Taylor give the following table from Remer, Devergie, and Casper, which shows that in more than two-thirds of all cases of *suicidal* hanging, the ligature is found encircling the neck, between the chin and *os hyoides*, or tongue bone :—

	Remer.	Devergie.	Casper.	Totals.
Above the Larynx .	38	20	59	117
On the Larynx .	7	7	9	23
Below the Larynx .	2	1	0	3
Total . .	47	28	68	143

You must not forget, that although in judicial executions a considerable fall is often employed, and always desirable, yet that *it is not necessary in order to ensure death by hanging that the feet should be off the ground.* MM. Tardieu and Taylor give plates and cases illustrating this point. A description of the plates of the former will serve to impress this fact.

Plate I.—Shows the suicide of the Prince de Condé. On August 27th, 1830, at eight a.m., he was found in a bed-room of the Château de Saint Leu, "already cold and stiff, hanged to the fastening of the window by means of two handkerchiefs, one round his neck, the other fastened to the window, and the points of his toes touched the ground: the distance between these and the fastening to which he was hanged was only six and a half feet. There were no traces of struggles or violence in the room. Tardieu, *loc. cit.*, p. 18. [Quoted from "Répertoire Général des Causes Célèbres Anciens et Modernes," t. xiv., p. 121, Paris, 1835.]

Plate II.—Shows a youth of sixteen, hanged by a simple loop, formed in a handkerchief, the knot being under the chin, but the handkerchief not going round the neck; he had put the handkerchief over a rope between two rafters of a granary. His toes rested on a heap of wheat, the knees being bent at an angle of about 100°, measured from the front.

Plate III.—Shows a prisoner hanged from the bars of his cell-window, by means of his shirt rolled up, to form a slip-knot; he was *almost seated on the window-ledge;* his hands tied in front, *and his feet resting on the ground,* the knees bent, but less than in the previous case.

Plate IV.—Another prisoner, hanging by the sleeve of his shirt, from a bar of the window, his feet touching the window-ledge.

Plate V.—An English pæderast, hanged himself in prison, from the bar of a window, with a rope made of his sheets, his feet having slipped on the floor; the attitude being that of sitting in the air, the lower extremities form an angle of about 120° with the body; and the head being inclined forwards towards the toes, forms a kind of semi-circle (arc-boutant).

Plate VI.—Shows a workman, hanging from the top of his bedstead, in a kneeling posture; his toes, but not his knees, touching the bed.

Plate VII.—A girl, hanging by a towel, with a slip-knot, from the bracket of a shelf. Her legs in sliding became stretched very widely apart, but the feet (heel of right, and toes of left foot) touch the ground.

Plate VIII.—A girl, in a penitentiary, hanged herself at the foot of the bed, by means of her chemise rolled up; she lay sideways, almost on the ground; the left arm, hip, and lower extremity touching the floor. She had lost consciousness, her face was red, the mouth open, and tongue protruding. She recovered, with appropriate treatment.

Plate IX.—A man, aged twenty-four, a prisoner, hanged in the corner of the window of his cell, by the help of the leather string of his hammock, to which he had attached a piece of linen, and his cravat. His feet were on the mattress, *and one hand was between his neck and the ligature.*

Plate X.—A prisoner at Mazas, hanging to the gas-pipe, at a height of 51 inches, by the thong of the hammock, and a cravat; *he is completely in a sitting posture on the ground;* one hand rests on the ground; and a plug of linen rag is stuffed into his mouth.

Plate XI.—Another prisoner, at the same place, hanging to the gas-pipe, by a slip-knot, made with the thong of the hammock; *he is kneeling on the ground,* his hands behind his back, and the face towards the ground.

Plate XII.—A prisoner at Mazas, hanging from the window-sash, in a remarkable position, the head being forcibly bent back, owing to the position of the knot under the chin. His toes touch the ground.

Plate XIII.—Represents a pæderast, aged sixty, hanging from the window-sash, by the same kind of leather thong, used by some of the other prisoners; one foot on the ground, *the other (right foot) resting on a chair.*

M. Tardieu has collected 261 cases of death from this incomplete form of hanging from MM. Marc, Esquirol, Jacquemin, Duchesne, Brierre de Boismont, and others. The results are as follows (*loc. cit.*, p. 22):—

The feet rested on the ground . . .	168	times.
The body was in a kneeling posture . .	42	,,
The body was extended and lying down .	29	,,
In a sitting position	19	,,
Huddled up or squatting (accroupi) . .	3	,,
Total . .	261	

It is worthy of notice that *hanging may occur quite by accident.* Dr. Taylor and M. Tardieu mention several cases (Taylor, *loc. cit.*, p. 49;

Tardieu, *loc. cit.*, p. 121). One was a little girl, swinging in a brewhouse, who accidentally caught her neck in the noose of a cord attached to a pulley, used to hoist the bodies of sheep just killed. She was thus suspended at a great height till dead. A boy, aged ten, was also killed by a noose catching his neck whilst swinging. In 1836 a gymnast, in practising with a rope in his bedroom, was hanged by it, though his feet remained on the floor. Near Haverfordwest they point out a spot where a man lay down to sleep, attaching the rope by which he was leading a sheep he had stolen to his neck; whilst he slept the sheep pulled the rope, and thus strangled him. Dr. Taylor mentions another case of a lad, aged fourteen, who had witnessed an execution at Nottingham, and determined to try what the sensation was like. The same day he was found dead, hanged from a tree. Similar cases are known to the Authors, chiefly occurring in boarding-schools.

Scott, the American diver, was in the habit (says Dr. Taylor) of making public experiments in hanging, and had frequently gone through them without danger, but in January, 1840, he died, during one of his performances. It is probable that a slight shifting of the ligature from under the jawbone, caused so much compression on the throat betwixt the chin and the larynx as speedily to produce asphyxia. No attempt was made to save him till too late; he *was allowed to hang thirteen minutes*, and not brought to the hospital until thirty-three minutes had elapsed. This case, like one of M. Tardieu's plates, shows that *the ligature or rope need not completely encircle the neck to cause death.* The fatal end may result by cerebral congestion, or rarely by syncope. *Hornshaw*, whose case was published by Dr. Chowne ("Lancet," April 17th, 1847, p. 404), was on three occasions resuscitated from hanging—a feat which he had performed to please the public! He stated that he lost his senses almost at once; that it seemed as if he could not get his breath, and as if some great weight were attached to his feet; he felt that he could not move his hands to save himself [this attempt is, however, sometimes made], and that the power of thinking was gone. Cerebral congestion may prove fatal at various periods after apparent recovery from hanging. Sir B. Brodie (quoted by Taylor) describes the case of a lad of seventeen dying twenty-four hours after he was cut down. Dr. Shearman reported another case ("Lancet," Jan. 6, 1844), where, in spite of careful treatment, death took place nineteen hours after. Dr. Richardson reports another on the second day, and M. Tardieu mentions several others.

Treatment of Persons Hanged, Strangled, or Suffocated.

The principles of treatment are mainly those which guide us in the treatment of the drowned. It may seem to some superfluous, but is not really so, to say that *in cases of hanging the first thing is to cut them down.* Whilst these sheets were passing through the press one young man, who, probably only meant to experiment on hanging, lost his life by those who discovered him running for assistance (which took ten or fifteen minutes), instead of promptly cutting him down. Next remove all tight clothing, whether round neck or chest. Artificial respiration should then be done, as in drowning; but should the body be still quite warm, cold affusion to the head and chest, ammonia to the nostrils, or other stimuli [pepper, or mechanical means of inducing sneezing, &c.,] might be useful. It might be necessary in some of these cases to bleed, and that not for cerebral congestion merely, but to relieve the right side of the heart, and in this way the pulmonary circulation. We have two or three distinct things to accomplish, both here and in drowning, and similar cases :—1st. To keep up respiration, and induce the natural process of breathing. 2nd. To keep the heart going, and to relieve the over-loaded blood-vessels. 3rd. To keep up animal heat. Cold affusion, ammonia to the nostrils, and artificial respiration, and the removal of all constriction, with perhaps galvanism to the phrenics or spine, are our means for the first indication ; warmth to the precordial region, acupuncture to the heart itself (should be done with a very fine needle), and galvanism, with perhaps enemata of brandy, and frictions to the limbs, are the means to fulfil the second ; whilst the third is met by blankets, hot bottles and tins, or hot bricks, and partly also by the frictions. There is a case of recovery by this means (quoted by Dr. Taylor) in the "Lancet" of July, 1839. A robust woman, of thirty-three years, hanged herself whilst drunk. She was missed about ten minutes—the time of suspension not known. Medical assistance reached her about ten minutes after being cut down. She was then quite insensible, pulse barely susceptible, breathing slow and laborious. Face pale, with no lividity, lower jaw sunken, extremities moderately warm, hands convulsively clenched, pupils dilated, and scarcely acting at all. A dusky red mark, a quarter of an inch wide, was seen round the upper part of the neck, forming an angle over the ramus of the lower jaw on the right side, where the knot of the silk handkerchief used as a ligature had rested ; in consequence of this the constriction was incomplete. She was bled freely twice, hot water applied to the feet, mustard to the calves, and cold to the head. After thirty-two ounces of blood had been taken from her, breathing became stertorous, the sphincters relaxed, pupils fully dilated, and the jaw dropped further. She appeared sinking. She was rubbed with ammonia liniment on the chest ; in an hour more she could swallow, but remained comatose till evening, though conscious of pain. She quite recovered. It is probably seldom necessary or safe to take so large a quantity of blood, but it may be said here that a stingy bleeding of only three or four ounces would seldom effect the object in view. From eight to twenty ounces is probably nearer the mark. No limit can be laid down which may not need to be exceeded in special cases. As an encouragement to perseverance in attempts to restore suspended animation, we quote the following case, which shows how long the heart continues to beat. We take it from Tardieu [who quotes Parrot, "*De la Morte Apparente,* Thèse de Concours," Paris, 1860, p. 61 ; see also "Med. Times and Gazette," July 1, 1854., quoted by Dr. Taylor.] Drs. Clark, Ellis, and Shaw of Boston, were the observers, and the man hanged weighed 130 pounds. He was aged twenty-eight years, and was very vigorous. The execution took place at ten a.m. There was "not the least perceptible struggle or convulsion," showing the absence of rapid asphyxia at all events. In this case the lungs and brain were normal, and death probably occurred from syncope, suddenly caused by the fall of the body (from seven to eight feet) at the moment of hanging. Whilst still suspended, the heart was heard to beat 100 times a minute, seven minutes after the suspension. Two minutes after the beats were ninety-eight per minute. In two minutes more the beats could not be heard. At twenty-five minutes past ten he was cut down, but the rope was not untied. No impulse or sound of the heart was perceptible ; his face was purple, although a small space near the ear seemed less congested. The tongue was not protruded, nor were the eyes staring; the pupils were dilated. The rope had been attached just above the thyroid cartilage. At 10·40 the ligature was relaxed, and also the ropes binding the arms. After this the face and body gradually became pale. The vertebral column had not been injured. There had been no emission of semen. At 11·30 a regular pulsation was observed in the right subclavian vein. On applying the ear to the chest this was found to depend on the heart, which was found to beat eighty times per minute. Only one sound was heard, regular and distinct, accompanied with a very slight impulse. Then the thorax was opened, and the heart laid bare, without stopping its movements. The right auricle contracted and dilated with energy and regularity. At [12] noon the pulsations were forty per minute. At 1·45 they were only five per minute. At 2·45 spontaneous movements ceased altogether, but irritability persisted till 3·18 p.m., more than five hours after the hanging. Although Dr. Clark does not say so, it is extremely probable that the sound discovered by auscultation, before the opening of the chest was due to the auricles rather than to the ventricles [see page 14]. The Authors, in quoting this case, do not wish to be understood as approving the opening of the chest before death was certain. It does, however, show that the heart, or a portion of it, retains life long after it might be supposed to be extinguished, and therefore encourages us to continue efforts at revival, in all cases of suspended animation. The *principles of treatment* are essentially the same in strangulation and suffocation, no matter the exact form. Only in some of these it may be necessary either to loose the ligature round the neck, or to free the mouth and throat from foreign bodies. *It may also be well to draw forward the tongue, and fix it by an India-rubber band;* and sometimes, as suggested by Dr. Brown of Haverfordwest, and Nelaton, in death from chloroform, to hang the body head downwards for a short time. In drowning and other deaths inducing cerebral hyperæmia this practice is likely to be more harmful than of use.

Post-mortem Appearances in Cases of Death from Hanging.

Omitting nearly all those common to death by apnœa, the special appearances are as follows:—The body may be stiffened in almost any position, according to the attitude in death [see page 935]. The tongue is often protruded, or pressed against the teeth, the pupils are nearly always dilated, the eyes often staring. The position of the head varies with the part of the neck where the rope or ligature is attached, and the position of the knot. *The commonest position is with the head forcibly flexed forwards,* the chin pressing against the upper part of the chest. Sometimes it is in the same position as in a man walking with head erect, sometimes bent a little to one side or the other. More rarely the head is completely bent back, as in cerebro-spinal meningitis, as in plate xi. of Tardieu (see page 936 of this chapter). In this case the knot was just under the chin. In fact, as Tardieu remarks, the head will always be found inclined to the opposite side to that where the cord which suspends it forms the knot which answers to its fixed attachment; and towards the same side as the middle of the loop thus formed for the neck. Hence, as the middle of the loop is nearly always in front, the head bends towards the chest. The hands vary in position like the head, and the fists are often closed, *and so tightly that the finger-nails often penetrate the palms.* But in incomplete hanging the hands may be stretched out, or rest on the ground open, and rarely one or more may be found fixed in the endeavour to loosen the rope. The legs also vary in position, as shown in the description of the plates, but they are generally somewhat livid. The face is sometimes pale, more often congested, especially in those who have been long suspended. On this point Esquirol,* Fleichman,† and Ollivier‡ (d'Angers), have given explanations, which Tardieu considers in great part theoretical. It is generally admitted that there is often froth stained with blood about the nose and lips. The neck is stretched in nearly all the cases, owing to the weight of the body. It presents marks varying with the kind of ligature, and the mode of its application, and the greater or less vitality of the tissues. In addition to ropes,—ribands, cravats or neck-handkerchiefs, pocket-handkerchiefs, sleeves or other portions of shirts and chemises, legs of trowsers or drawers, sheets, curtains, garters, leather thongs and straps, loops of curtains, and bed-furniture, have all been employed: whilst window sashes, a bar across folding doors, nails, hanging shelves, the posts or the foot of a bed, the banister of a staircase, the rungs of a ladder, &c., have all been used to attach the ligature. The mark will vary with the size and stiffness (or the reverse) of the rope or other ligature, and with the kind of knot or loop formed, which may be a single, double, running, or slip knot, or merely a loop. As before said, it need not go all round the neck to destroy life. The knot (as before remarked) may be in front, or behind, or at either side. Its position in 143 cases (as given by Remer, Devergie, and Casper) has been noted at page 935. Rarely, when the hanging has been brief, and the ligature soft and supple, there may be scarcely any mark at all. More often *there is a groove or furrow* [*Sillon*, lat. *sulcus*] *in the neck which*, in 81 per cent., will be between the chin and the larynx, or upper part of the windpipe. This may be oblique in direction, and the mark is often interrupted. This furrow is single or double, and regular or irregular like its cause. A single rope, &c., going twice round the neck would leave a double mark; these marks are not always parallel when double. Orfila justly insists on this. A large single thick sewed leather thong, pressing only by its borders, would leave a double mark. [Tardieu, from observations in the prison of Mazas.] The furrow may not quite correspond to the size of the ligature. In general, the narrower the ligature or cord, and the longer the hanging, the deeper the furrow. In cases of short suspension the colour may be quite natural. So, also, when the blood-vessels and skin are young and healthy. *More often, indeed, sometimes after only short suspension, the furrow undergoes a sort of dessiccation, and becomes like parchment.* As noted by Ollivier (*d'Angers*) and Caussé (*d'Albi*), above and below the borders of the furrow, which are slightly raised in most cases, the skin is usually violet, due generally to congestion. Remer explains it by extravasation, and this may perhaps occur sometimes. Rarely there are slight excavations in this furrow, and small superficial ecchymoses. *There may also be finger marks*, even in *cases of suicide.* Note their *direction, size, and number.* If the furrow be cut into, blood sometimes escapes. *The state of the genital organs* is often one of turgescence, so that in males the penis is more or less erect or large, and there is an emission of something like seminal fluid, which is really prostatic in most cases, and may be mixed with blood. In the female there may be an erect clitoris, and there often is a sort of spurious menstruation. There is, however, no reason to believe that any pleasurable feelings are connected with this [Brierre de Boismont, Rouget, and others quoted by Tardieu, *loc. cit.*, pp. 38-9].

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* "Arch. Gén. de Méd.," 1mière série, t. i., 1823, p. 13.
† "Annales d'Hygiène Pub. et de Méd. Leg.," 1re série, t. viii., p. 132.
‡ "Annales d'Hyg. et de Méd. Leg.," t. xxiv., p. 314.

The special internal appearances met with in hanging are :—

(1) Rarely fracture or dislocation of cartilages of larynx—most probable in elderly people.

(2) *The same lesions in the Os hyoides* or *tongue-bone*, also very rare.

(3) Amussat and others (first in 1828) noticed that the *middle and inner coats of the carotid artery may be divided.*

(4) There may be dislocation of the cervical vertebræ, especially fracture of the odontoid process, and rupture of its ligaments, with dislocation of axis and atlas (see page 934, and figures explanatory).

(5) The larynx is usually deeply congested (red but not violet, the latter tint being due to putrefaction). There will generally be some blood-tinged froth, here and in the bronchi.

(6) As regards lungs and heart, the conditions will vary, according as death has occurred, from syncope or asphyxia, &c. (see page 634). Tardieu denies punctiform ecchymoses, or apoplexies, unless there has been suffocation.

(7) The *stomach* (as pointed out by Yellowly, Chevers, and Taylor) *is often congested so much as to resemble the effects of irritant poisoning.* Guy's Hospital Museum contains some fine specimens of this.

(8) There is rarely any apoplexy in these cases, or much congestion of the cerebral vessels. It has been found that opening the windpipe beforehand below the ligature prolongs life for some time. A dog so treated lived three hours suspended.

Hanging, or Suspension after Death.

Casper found in his experiments that if a body were hanged immedidiately after death (say within one or two hours) the appearances as to the mark of the cord, &c., were just the same as if death had taken place by hanging. In one case seventy-two hours had elapsed! [" Klinsche Novellen," 1863, p. 489.] These remarks apply almost exclusively to the outside of the body, and to the neck in particular. Casper's conclusions are somewhat contradictory in regard to his experiments at different times. But Taylor and others adopt his conclusions, in the main, as we also are bound to do, so far as that if the tissues preserve a certain amount of vitality the cord will produce marks. The blood, however, would probably be less fluid, and there would not be extravasations of blood.

Your answer to the question, " *Was death caused by hanging?*" can seldom be positive as regards the medical evidence alone, since we have seen that there is no one sign peculiar to hanging constantly met with.

The second question, " *Was death suicidal or homicidal?*" must also depend on a variety of circumstances, and, like the former, can seldom, if ever, be answered merely from post-mortem appearances. *You must carefully note the surroundings*—the absence of all signs of struggling, the absence of marks of injury on the body, the previous history of the defunct, the time, place, and manner of the hanging, will all aid you, if guided by common sense, to frame your answer. Do not pretend to superhuman sagacity! It is often erroneous to say that the feeblest people cannot take their own lives, for experience is against this theoretic view. A resolute invalid or valetudinarian can do wonders. Dr. Taylor has given cases, in which suicides first wounded themselves, and then finished their self-slaughter by suspension! See also Casper [" Gericht Leich. Oeffn.," vol. ii., p. 89, and " Annales d'Hygiéne," 1848, 1. 444.] *Where serious wounds of the heart, throat, &c., have been inflicted, threatening syncope from loss of blood, we must usually suspect murder.* So also where there are other marks of violence on the body; or the furniture of the room, or other surroundings, shows traces of severe struggling. If both doors and windows are found fastened from the inside, suicide would generally be probable. But this fact is scarcely medical evidence. Still, a trained observer such as a medical man is supposed to be, is wrong to overlook these things, and leave them all to the police to discover. *Remember that poison may have been given beforehand, and the body hanged to avert suspicion.*[*]

Illustrative Cases.

No. I.—*Suicide supposed to be murder, popular prejudices on the ground of religion. The case of Marc-Antoine Calas. Erroneous medical evidence.*

We quote this case because many of the English versions [even that of Dr. Taylor] are incorrect in some details. [See Voltaire's " Traité sur la tolérance à l'occasion de la mort de Jean Calas;" " Nouveaux mélanges Philosophiques Historiques," &c. IIme partie, édition de 1772

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[*] Whilst these pages were being printed Dr. Ogston of Aberdeen published the following in the " Medical Times and Gazette" for Nov. 11th, 1876, as the result of a personal examination of forty bodies of persons who were either hanged by others (executed or murdered), or hanged themselves (suicidal cases) :—

In twenty-one (or 52·5 per cent.) the features were calm and placid. In one (a suicide) the expression was extremely anxious, and the eyeballs very prominent.

In thirty-nine (or 97·5 per cent.) the *pupils were dilated;* in only one case were they contracted.

In one case the external auditory canal on both sides was full of blood.

In fourteen cases (or 35 per cent.) *the tongue was protruded or marked by the teeth.*

In three only was there froth at the lips, and in one at the nostrils.

In ten (or 25 per cent.) or ¼ of the cases there were signs of *excitement of the genitals.* The penis was erect in seven, semi-erect in four; in eight there were discharges of prostatic fluid; of urine in four, of blood in two (one male, one female).

On examining the neck the only uniform appearance was the groove or furrow left by the ligature. This mark, if single, was not continuous, owing to the prominence of the air-tube, and of the sterno-mastoid muscles.

In twenty-seven (or 67·5 per cent.) the bottom of this furrow was whitish.

In thirteen (or 32·5 per cent.) it was parchmented, dry, brown, and horny. In five it was abraded. In two reddened. There was usually a white, silvery, and dry streak at the points of greatest pressure. There was injection of the skin at the bottom of the groove [ecchymoses of cervical venules] in five (in 12·7 per cent.). As noted by Neyding and Bremme [" Annales d'Hygiène," &c., No. 79, pp. 288–9].

There was redness of the mucous membrane of the trachea in 36·6 per cent. (or 14 out of 40). Dr. Ogston's well-known character as a careful observer renders these results valuable.

Although, therefore, Taylor, Tardieu, Devergie, and others, admit that we have

(t. xxxii., p. 30), containing the "Pièces originales concernant la mort de Sieurs Calas:" and Tardieu, *loc. cit.*, p. 67, &c.

Jean Calas, aged sixty-eight, was a Protestant merchant of Toulouse, of excellent character. His wife and family were all Protestants, except one son [Louis Calas] who had become a Catholic. One of his favourite servants was also a Catholic. One of the sons, *Marc-Antoine,* was a man of letters, but considered to be of a turbulent disposition, gloomy and violent. Having no taste for business, and being hindered from the practice of the law on account of his Protestantism, he resolved to end his life, communicated the idea to one of his friends, and read all he could find in books on the subject of suicide. At last, on the 13th October, 1761, having lost some money by gambling, he determined to carry out this project. One of his friends supped with him and other members of the family. After supper they went to another room. Marc-Antoine disappeared when the friend was about to take his leave; the brother Pierre (Calas' second son) went downstairs with the friend, and found Marc-Antoine hanging in his shirt, from a stick or billet of wood placed across folding-doors, partly open, which led to the shop. His other clothes were folded up on the counter; his hair was neatly arranged; there were no marks or signs of injury of any kind on the body [some slight marks were afterwards caused by carelessness in carrying the body to the town-hall]. The cries of the unfortunate family caused a great crowd to assemble. Some fanatic cried out that the old man had murdered his son by hanging him, out of hatred to the Catholic religion. The mob took up the cry, and some said the friend (Lavaisse) had helped to hang the deceased. The whole family, their friend, and even the Catholic servant, were put in irons. Improbable as it was that the old man alone could have hanged this youth of twenty-eight, he was condemned to death [to be broken on the wheel]. A surgeon named Lamarque declared that the remains of food found in the stomach had been taken four hours. [They had really only been taken two hours. See on this point the article on *Starvation.*] The public hangman denied the possibility of hanging across folded doors in the manner described! Great stress was laid on some slight contradictions in the evidence of the father and brothers, as to whether the old man said he had cut down his son, and on their first wish to conceal their grief and shame. Yet it is to be noted that Pierre and his friend Lavaisse went themselves to the officers of justice.

The poor old man was first tortured and then executed on the wheel, and the youngest son banished for ever. Voltaire (greatly to his credit) exerted himself for three years to defend the memory of Calas, and to reverse the sentence against the son. On the 9th day of March, 1765, fifty judges who had investigated the circumstances declared Calas altogether innocent, and that Marc-Antoine had committed suicide. The king, by his liberality, sought to compensate the unhappy family as far as possible. The medical witnesses had never examined the cord, nor the place where the hanging occurred. See also Beck (*loc. cit.*, p. 567),

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no absolutely certain post-mortem signs of death by hanging, most medico-legists admit that it is very seldom the medical witness will really have much doubt as to the cause of death if he be careful to look for and note the combination of several of the lesions named, together with the mark or furrow on the neck, which will seldom indeed be absent; and to note at the same time the surroundings of the body.

Foderé (vol. iii., p. 167, from the "Causes Célèbres," and Grimm's "Historical and Literary Memoirs" (from 1753 to 1759), vol. ii., pp. 41, 117, and 166.

CASE II.—*Doubtful Murder or Suicide. Case of Sarah M. Cornell.*

[Abridged from Beck, *loc. cit.*, p. 571-3, and note to page 179, who gives original references, including private letters, and refers also to "Boston Medical and Surgical Journal," vol. viii., p. 334.]

On the 20th December, 1832, S. M. Cornell, a factory girl of immoral character, known to be pregnant from her own confession, left her home in the evening in good health and spirits, and was found dead on the morning of the 21st suspended to a stake. Her cloak was hooked together, except one hook about the centre of the chest. Her calash was on her head, and her gloves on her hands. Her shoes off, about eighteen inches from the body, a little mud on one of them. Her toes only touched the ground. The knees nearly approached the ground, and her clothes were smoothed back as far as they would reach under her legs. The cord was of hemp, small in size, and taken twice round the neck, attached to the stake about six inches from its top. Its length, from the stake to the neck, was less than six inches. Her calash (or hood) was so far back on the right cheek that her face rested against, and was marked by the stake. One witness (a seaman) described the knot as a *clove hitch.* He added that it must be drawn at both ends horizontally to tighten it.* The knot was at the right side, and the strings of her calash were under it. A groove or furrow was round the neck horizontally, so deep that whilst just below the neck measured 11½ inches round, in the groove it was only 10½ inches. It was above the thyroid cartilage, 1¼ inch below the lobule of the ears on each side. The face was pale. The tongue slightly protruding. The females who laid her out on the same day found finger-marks passing upwards on the abdomen, and bruises on the legs, the worst bruise on the back of the hip. There were scratches on the knees, with some dirt. One knee seemed stained with grass, and one witness (a female) swore that she picked grass from it. The vagina was bloody, her linen stained with blood. Fæces evacuated and flattened. The right arm raised, quite stiff, and under the cloak. A physician (who knew from herself of her pregnancy) was called in, and inclined to the idea of suicide. She was buried, but exhumed two days after, on account of suspicions. Further medical examination revealed parchmentation of the furrow in the neck, healthy stomach, lungs gorged with black blood, abdomen livid and discoloured [they do not speak of finger-marks]. The other appearances noted by the women they confirm, especially as to the grass stain. The uterus was examined, and a fœtus found. The membranes were entire. The fœtus weighed five ounces, and measured eight inches. It had neither nails nor hair. The alleged date of conception was 30th of August; the last catamenia August 21st.

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* Beck figures this knot. So do Erichsen, Druitt, and other writers on Surgery. It is made thus: Take a string [or rope, round towel, &c.], and make first one simple loop, then another like the first, and put the last-made loop behind the other. Your *clove-hitch* is then made. It is much used to reduce dislocations, because it can only be tightened in the manner described by the sailor whose evidence is given above. It is used by seamen.

Death took place on December 20th. A question was raised—Which is most probable, that a fœtus, aged only three months and twenty days, should be so large, or that she menstruated after conception? [See pages 644 and 688.] On the 26th of January the body was again examined, but fruitlessly. A man called Avery was tried for the murder of this female. Whilst it seems certain that death was caused by strangulation or apnœa, there are many difficulties connected with this case. The authors confess that the clove-hitch, and some other circumstances, incline them to the idea of murder by some person or other.

The case of the Prince of Condé, Duke of Bourbon, father of the unfortunate Duke d'Enghien, has been mentioned at page 935. Both Taylor, Beck, and Tardieu, give this case at some length.

Many years ago a tailor named George Hebner was found hanging to the top of a bedstead in the garret of a house of ill-fame, kept by a widow named Hughes, in Dean Street, London. *His hands were tied behind his back,* his handkerchief drawn over his face, and the *rope round his neck was fastened by a sailor's knot.* These circumstances led to the arrest and conviction of a sailor called Ludman, who, with Mrs. Hughes, was found guilty and executed. Beck, *loc. cit.*, p. 566; Paris, vol. iii., p. 44.

CASES IV. and V.

[Taken from Tardieu, *loc. cit.*, p. 73, 74, &c.]

Suicidal Hanging mistaken for Murder.

In the first case, a married woman of loose morals, who had twice brought on abortion, and was nearly always drunk, was found by her husband, hanging in a crouching position by a rolled-up handkerchief attached to the key of her chamber door [the keys are often large in Normandy] at a height of only ninety-eight centimetres, or little more than three feet from the ground. He tried to conceal her mode of death and [on medical evidence, which M. Tardieu shows to be quite erroneous] was sentenced to the galleys, where he died within about a year. As evidence of the medical errors take the *denial* of the possibility of death by partial suspension, the description of the marks in the neck (produced by the handkerchief) as done by hands, and the further denial that blood ever comes from the nose in cases of hanging!

The second case was one in which a husband was accused of having strangled his wife, age forty-eight, who was found in a loft or granary, in a sitting posture, propped up against some planks, below a beam from which a broken rope still hung. The rope had broken by her weight. The husband, who found her at 8·30 a.m., first carried her to her bed, and only sent for a doctor some time after, who arrived at 11·30. She was then quite cold and stiff, and there were marks like those of fingers (besides a furrow where the rope had been) on the neck. The case was referred to M. Tardieu, and his investigation is masterly. He shows that the place was adapted for suicide, and bore no marks of a struggle; the rope had broken by slowly yielding under the weight [of say 99 to 112 lbs., for the body was nearly naked]. It was attached to the beam by a simple bow-knot (rosette), whereas murderers usually tie very firm knots; he shows that the marks on the neck (figured at page 80 of his work) were consistent with hanging rather than strangulation; the mark was single though the rope was double ; finally, that the ecchymoses might have been produced by her own hand (as in plate ix. of his book, explained by us at page 936) ; and that this explains the sinuosity and inequality of the mark. Finally, he argues against strangulation from the pallor of the face, and the absence of pulmonary engorgement. [Our readers should consult both Taylor and Tardieu on this subject. Taylor's cases of hanging with wound of heart, and with severe wounds in the neck ; and of gunshot wounds with hanging, suggesting murder, especially one quoted from M. Dégranges, [*loc. cit.*, p. 48] should be studied both by advocates and medical men who have similar cases to report on.]

Death by Strangulation.

By this, as distinct from *hanging* or *suspension*, we mean death, from pressure applied either by a ligature round the neck, or by direct pressure of the hands, or otherwise upon the windpipe, or other parts of the neck. In Spain the customary mode of execution is by a steel collar (*garrote*), tightened by a screw, whilst the criminal is seated, and fastened to a pillar or post.

In *Turkey* and some other Eastern countries suffocation by the bowstring is a common mode of execution. The notorious *Thugs* of India used a *cummerband*, or soft loin cloth, leaving little mark, but knotted.*

In England the term *garotting* is used to signify the forcible compression of the neck done by thieves on the highway, or otherwise. These gentry usually attack from behind. There is a popular notion that they use chloroform or other anæsthetics to aid their nefarious designs. There does not, however, seem to be any real foundation for this. As the same plea is sometimes raised to excuse voluntary submission to a rape it may be as well to note here :—

(1) That all anæsthetics, even the most rapid in action, necessitate time, varying from about two to five minutes is the case of chloroform, and a longer time in the case of ether. Although some anæsthetics are known to scientific men which act rather more quickly, they are not sufficiently common to be used by garotters, and need not therefore be named here.†

(2) During this time there is ample opportunity for struggling and crying out, although

(3) In very nervous persons fright may induce syncope, and thus aid the evil designs in hand.

General Observations on Strangulation.

Tardieu and Taylor justly insist on the greater force required (in adults at least, and *mutatis mutandis* in infants), to *strangulate* than to *hang*. As, therefore, *hanging*, except in the case of *executions*, or of the bodies hanged post-mortem *for the most part means* SUICIDE, so *strangulation*, accidents excepted, *for the most part means* MURDER. Let us explain what we mean by accident. The case referred to at page 937, of a man hanged by a sheep was more properly strangulation, or would have been so if he were lying on level ground. Again, Dr. Gordon Smith tells of a lad who used to carry a heavy weight suspended from his neck by a string. One day they found him, quite dead, sitting in a chair. He had probably gone to sleep, the weight had slipped, and drawn the cord tight round his neck, Dr. Taylor records the case of a girl who carried fish in a basket at her back, suspended by a leather strap passing round the front of her neck, above her shoulders. She was found dead (in June, 1839) sitting on a stone wall, the basket had slipped off, probably whilst she was resting, and had thus raised the strap, which had forcibly and fatally compressed her windpipe. Dr. Taylor saw a case in Guy's Hospital in Nov., 1864 [figured in his work, vol. ii., p. 66] of a boy, "aged fourteen years, whose silk necktie, knotted and tightly twisted round his neck, was caught in the band of an engine and his neck drawn down against one of the revolving shafts. His neck was thus compressed about one minute. There was a deep circular depression, three-quarters of an inch wide all round it. The neck was twelve inches in circumference, while the inner circumference of the handkerchief which compressed the neck was reduced to eight inches ! He became black in the face, and blood escaped from his mouth and ears. For six or seven minutes after the ligature had been removed he was insensible. He then revived, and was able to speak, but could not hold up his head. When brought to the hospital soon afterwards he was sensible ; his face was pale, his lips were livid, his eyes suffused, and the conjunctivæ injected. He breathed without difficulty, and only complained of pain when he moved his head. The boy told Dr. Taylor that at the time of the accident he felt no pain ; he had a sense of choking, and then became insensible. *For at least one minute* no air entered his lungs. He recovered and left the hospital in about eighteen days."

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* Sometimes they used a *lasso*, or long thong, with a running noose.

† Sansom "On Chloroform, &c.," pp. 27, 28. See also Anstie "On Stimulants and Narcotics."

Dr. Taylor very properly advises a photograph or drawing to be made at once of the position of the body and surrounding objects. This advice [see pages 7 and 8] applies to all cases of bodies found dead under doubtful circumstances. Although *strangulation usually means murder* certain cases of undoubted *suicide by this method* are now known to medical jurists. Wherever *marks of fingers* ALONE are present to explain the death, we must suspect murder, for the pressure applied by a would-be-suicide, by means of his own fingers, would be relaxed as soon as he or she became insensible. But the methods of *partial hanging*, described at pages 935-6, in reality amount to strangulation, and determined suicides either tighten the ligature with a stick [as in the case reported by Mr. Thorp in the "Guy's Hospital Reports," October, 1851, and in the case of General Pichegru [see Illustrative Cases, No. V.], or by a rough cord passed two or three times round the neck, and tightened by each hand [" Guy's Hosp. Rep.," *loc. cit.*, supra]. Rarely one foot, or both lower extremities, have been used to tighten the knots, by twisting them in loops [*quasi stirrups*].* Sometimes one tight knot has sufficed ; or a double knot has been tried. Dr. Taylor quotes the case of a young woman of Montevrin, in the Canton of Lagny, found dead in bed, lying on her face, with a woollen garter passed twice round her neck, secured in front by two simple knots, strongly tied the one on the other. Putrefaction had set in. The medical witnesses, without examining the head, gave it as their opinion that she died from apoplexy! Yet the state of the lungs, and the ecchymosed patches in different situations, pointed to death by apnœa ["Ann. d'Hygiène," 1829, 2, 440. Dr. Taylor also refers to a case by Dr. Simeons in Henke's "Zeitschrift," 1843, 1, 335]. Dr. Taylor also describes and figures (*loc. cit.*, vol. ii., p. 68) a case from *Dr. Schüppel of Tübingen, in which he was able to verify the fact of strangulation after the burning of the body!* The victim was a lad aged ten years, but the circumstances pointed out his step-father as the murderer, and probably the incendiary. Although the boy's neck was much burnt, the mark of a ligature was very distinct on it, varying from a $\frac{1}{4}$ inch to $\frac{3}{5}$ of an inch in width, and one-eighth of an inch in depth.

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* Greenacre attempted to destroy himself thus, but a timely discovery permitted of his being resuscitated.

Again, in the case of the *Countess of Goerlitz*, whose body was burnt, the protrusion of her tongue from the mouth first suggested that she had been strangled first. Ultimately *John Stauff*, her servant (who was tried for this crime at Darmstadt in 1850), confessed that he had murdered her in this way. (Taylor, *loc. cit.*, vol. ii., p. 69; vol. i., p. 703.)

Homicidal strangulation has been done by the hands (leaving marks of fingers and thumbs); and by ligatures of various kinds, hemp, leather, &c., simply drawn tight, and knotted, or twisted with a stick, &c., as in the common *tourniquet* employed by old-fashioned surgeons. [See the Illustrative Cases.]

As in the case of *hanging*, the questions which arise are usually simple, so it is in *strangulation*. The most probable questions are:—

1st. Was death caused by strangulation? in other words by the forcible compression of the throat?*

2nd. Was the strangulation accidental, suicidal, or homicidal?

3rd. How long has death occurred?

To answer the first question we must enquire into

The Post-mortem Appearances in Death by Strangulation.

In the majority of cases death will be due to apnœa [so-called *asphyxia*]. All the appearances of this mode of death will be present, even more markedly than in hanging. The face and extremities will be more livid ("violet" or "black" are the words used in many cases.) Blood may issue from the nostrils, mouth, or even ears; the eyeballs will generally be prominent and bloodshot, and the pupils dilated; the genital organs will generally be turgid, as in hanging; and urine, fæces and semen will in all likelihood have been discharged; the lungs, right heart, and venous system, will sometimes be gorged with blood. M. Tardieu (*loc. cit.*, and "Ann. d'Hygiène," 1859) states that the lungs are seldom very full of blood. The same may be said of the right heart. But there is always, according to him, an extreme and remarkable degree of *emphysema*, and air will be found under the pleura. He regards punctiform ecchymoses as rare, but says that pulmonary "apoplexies" are very common: in other words, there are extravasations of blood, of some size in the lungs. The blood will be very dark and very fluid.

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* Forcellini, quoted by Tardieu, defines Strangulation thus:—"STRANGULATIO, *actus strangulandi* (suffocated); *a voce græca allata*, *στραγγαλάω*, *gulam comprimo, et spiritum intercludo*," "from *στραγγεύω*, the same, doubtless," says Tardieu, "as *στρεύγω*, which expresses the action of twisting." By modern writers, *suffocation* is made a separate mode of death.

The principal differences between *homicidal strangulation* and hanging will probably be :—

1st. That the *mark* of the *rope* or *ligature, though perhaps less deep than in hanging, is more complete,* that is, it is usually circular, and goes all round the neck, more horizontally than in hanging. *There are generally other marks of violence on the neck and other parts of the body.* In *cases of throttling and garrotting there will be marks of fingers and thumbs.* These, in infants and very young persons, or very thin persons, may be confined to the front or sides of the windpipe. Such marks should, if possible, be photographed, at all events sketched, and measured on a scale of lines, millimetres, or some similar division. Bruises and scratches, perhaps even more serious injuries, will be found on the body. Do not forget to examine the genital organs and their vicinity, particularly in females.

Casper states that these marks can only be produced a very few hours after death, certainly not after six hours. On this subject see the general remarks in the next chapter on Wounds and other Injuries. When these marks are produced in a dead body we should probably find other causes of death, and the internal appearances would be different.

It is said that when soft materials (such as cambric, muslin, or cachemere) are used, no marks or very slight marks are seen. The *Thugs* are supposed to operate thus artistically. The authors believe that the riddle is solved by *suffocation* being added to slight preliminary constriction of the throat. The tongue is often protruded or bitten.

The deeper parts of the neck are often injured severely, and fractures of the hyoid-bone, of the cartilages of the larynx, &c., together with injuries to the cervical vertebræ and to the blood-vessels, and nerves of the neck, may all be met with in homicidal cases ; though perhaps less frequently than in hanging when the suspension has been accompanied by a fall.

2nd. There is more *congestion of the larynx, trachea, and air-passages, than is usual in hanging ; and froth, nearly always blood-stained, is invariably present, according to Tardieu.* Remember, that if called to a body still warm some of these marks may not have had time to appear ; they are most evident in persons on whom strangulation has been attempted, and who have more or less recovered. The after effects of such attempts are often very serious. In addition to the convulsions, and swelling of throat and neck, and lower part of face, and upper part of chest, met with in these cases at first, there may be subsequent pulmonary and laryngeal troubles, paralysis, the formation of abscesses, and bed-sores, and death at a period somewhat remote from the attack.

The Treatment of Strangulation.

From what has been said it is quite evident that our principles of treatment must be the same as those given for hanging—viz., Removal of all constriction from the neck, artificial respiration, and (if the body be not cold) cold affusion ; perhaps galvanism, stimulants to the nostrils, &c., alcoholic stimulants and light nourishment by the mouth, or per rectum ; if the body be cold, hot bottles and chafing or rubbing the limbs, as in drowning, and sometimes venæsection should be adopted. The subsequent treatment must be guided by the usual principles of medicine and surgery; and depends on the symptoms, whether pneumonia, or the local injuries to the neck and other parts, or the effects of shock, &c., have to be combatted.

The Duties of Medical Experts.

The outline just given, and the illustrative cases will enable you, if diligently studied, to answer questions as to the mode of death, and the probabilities of suicide, accident, or murder, in most cases of strangulation. The following remarks will assist you not only in forming your judgment, but in framing a systematic and complete report.

Premising that you are called in early, and have the opportunity of making a complete investigation, supposing death to have taken place, you should

1st. *Examine carefully the place where the strangulated body is found, its position and surroundings.* The evidences of a struggle, marks of blood, &c., upon the floor or ground, on the clothes, or on articles of furniture, may all be important accessary proofs of a murder.

2nd. *Examine carefully any rope or other ligature round the neck*, or in the absence of these the body itself for marks of fingers or other means of strangulation. Case I. appended (from Dr. Taylor) shows the importance of examining the ligature in cases of supposed hanging. You may be asked questions as to the strength (or breaking weight) of ropes, cords, leather thongs, &c. As the materials used now-a-days, even in the construction of cordage, are so various, you should institute an experiment in every case. The strength of a rope is that of its weakest part. You may test this by suspending it (by a loop) from a ring or iron hook, and adding weights till it breaks.*

3rd. *Examine the outside of the body carefully* before proceeding to the next step, which is to

4th. *To make a careful examination of the inside of the body*, especially of the neck and thorax.

5th. *The previous personal and family history of the deceased should be carefully inquired into, as to mental or body diseases and the like*, not necessarily for disclosure, but for your own guidance. But remember that a maniac with a tendency to suicide may have enemies.

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* Such rules as "To estimate the strength of a cord of hemp, multiply by 200 the square of its number of inches in girth, and the product will express in pounds the practical strain it may be safely loaded with; for cables, multiply by 120 instead of 200. The ultimate strain is probably double this. In cables, the strength, when twisted, is to the strength when the fibres are parallel, as about 3 to 4"—given by Gregory and others, are not of practical use for the small cords, &c., we meet with in cases of hanging and strangulation. The only safe way of answering is to experiment. As some guide to the comparative strength of materials, we give the following table of the breaking strain of the following fibres. Although differently stated, the results are almost identical :—

Fibre.	De Candolle.	Labillardière.
Flax (*Linum usitatissimum*)	11·7	1000
Hemp (*Cannabis sativa*)	16·3	1370
New Zealand Flax (*Phormium tenax*)	23·8	1996
Pita Flax, or American Aloe (*Agave Americana*) .	7·	596
Silk	34·	2894

Special Law relating to Garotting, &c.

By the 24th & 25th Victoria, c. 100, § 14, it is enacted :—That whosoever shall *attempt* to *drown, suffocate, or strangle* any person with attempt to commit *murder*, shall, whether any bodily injury be inflicted or not, be guilty of felony, and being convicted thereof shall be liable, at the discretion of the Court, to be kept in penal servitude for life, or for any term not less than three years * * * * * or to be imprisoned for any term not exceeding two years." As the intent in cases of *garotting* is usually robbery, it is provided by Section 21, in order to check this crime, that, "Whosoever shall, by any means whatsoever, *attempt* to *choke, suffocate, or strangle*, any other person, or shall *by any means calculated to choke, suffocate, or strangle*, attempt to render any other person insensible, unconscious or incapable of resistance, with intent, in any of such cases, to enable himself, or any other person, to commit, or with intent in any of such cases thereby, to assist any other person in committing any indictable offence, shall be guilty of felony, and being convicted thereof shall be liable, at the discretion of the Court, to be kept in penal servitude for life, or for any term not less than three years * * * * or be imprisoned for any term not exceeding two years," &c.

We do not agree with Dr. Taylor in his regret that the *lex talionis* is not more resorted to in such cases, as we regard even the use of the lash as a return to barbarism. What we believe to be essential is that the punishment of such crimes should be not so much severe as certain, and not so much a mockery as a life sentence becomes when the criminal is let off with a ticket-of-leave after a very short term of imprisonment.

Illustrative Cases.

No. I.—Supposed Suicidal Hanging, *the ligature* (*or tape*) *is found too weak, further examination reveals severe injuries to neck and throat.*

[Dr. Taylor, *loc. cit.*, vol. ii., pp. 71-2.]

"In *Regina* v. *Pinckard*, Northampton Lent Assizes, 1852, it was proved that deceased was found in a sitting posture in a corner of her room, on the floor, with a narrow tape round her neck hung loosely and singly over a small brass hook about three feet above her head. Her clothes were placed smoothly under her, and her hands were open and stretched out by her sides. [Dr. Taylor gives a sketch of the room and body, in position.] There was a severe bruise over the right eye, and there were marks of blood on the tape as well as on the floor and wall of the room at a distance from the body. There was a stain of fresh blood on the knot of the tape where it passed over the hook, and there was no blood on the hands of the deceased. The windpipe for about 1½ inch was lacerated longitudinally in its rings, and there was a deep circular mark round the neck in the course of the doubled tape, as if either from great pressure applied by some person, or from the weight of the suspended body. The latter hypothesis, so far as the tape round the neck was concerned, was untenable. *The body of the deceased did not weigh probably less than* 120 *pounds, whilst the tape found round her neck broke with a weight of forty-nine pounds*, hence the deceased could not have been freely suspended by it.* Apart from this the injuries to the parts about the neck, including the longitudinal fracture of the windpipe, were not such as the tape could have produced as a result of partial suspension in the position in which the deceased's body was found. The noose had been so placed that the greatest pressure was on the back of the neck, and the least in front, where the greatest amount of mechanical injury was actually done. The deceased had been strangled probably by manual violence in the first instance, and afterwards by the use of a ligature drawn tightly by the hand. The body was then looped up with the double tape. These facts, taken in connection with the smooth arrangement of the clothes, the severe marks of violence on the body (inexplicable on the hypothesis of suicide) and the marks of blood and of struggling in the room, proved that there had been homicidal interference; and the crime was brought home to the prisoner by a series of moral and circumstantial proofs inconsistent with her innocence, and only consistent with her guilt." The prisoner had been a nurse accustomed to "lay-out" dead bodies, and she appears to have placed the corpse in the above case, in what she considered a "becoming attitude." Dr. Taylor remarks that in the case of *Drory* the criminal had attempted to make the death appear suicidal by placing the lower end of the rope near the hand of the deceased; but he selected the left hand, whereas the deceased was right-handed; and he did not leave enough rope free from the neck for either hand to grasp in order to produce the violent constriction of the neck, caused by the two inner coils. Both these criminals confessed their crimes before execution.

CASE II.—*A Physician Strangled in his Coach.*

[Beck, *loc. cit.*, p. 576.]

"Dr. Clench, a physician in London, was called out of bed by two persons on the night of the 4th of January, 1692, who desired him to visit a friend who was not well. He entered a hackney-coach with them, and drove about several streets in the city for an hour and a quarter. The two individuals then left the coach, and sent the driver on an errand. When the coachman returned he found Dr. Clench sitting on the bottom of the coach, against the front seat, with his head against the cushion. Thinking him in liquor he shook him, but obtained no answer. He then called the watch, and they found him strangled by a handkerchief, in which a coal had been placed, and then the coal applied directly over the windpipe. The coachman had heard no noise whilst driving the carriage." [Hargraves' "State Trials," vol. iv., p. 495.]

CASE III.—*Murder or Suicide? The case of Sir Edmundbury Godfrey.*

[Beck, *loc. cit.*, p. 574; Hargraves' "State Trials," vol. ii., p. 759-791. Beck gives other references.]

The supposed murder in this case was, no doubt erroneously, attributed to Roman Catholics. "Sir Edmundbury Godfrey, an eminent magistrate in London, was on the 12th of October, 1677, found dead in a ditch nearly a mile out of town. His sword was thrust through him, but there was no blood on his clothes or about him. His shoes were clean, his money in his pocket, his neck, which was open, without anything on it, had a mark all round an inch broad. It was also dislocated. The breast was marked with bruises. This is the statement of Bishop Burnet, who went to see the body. Subsequently several individuals were tried in the Court of King's Bench, for publishing letters importing that Sir E. Godfrey had murdered himself. Though a case of libel, they endeavoured to defend themselves by calling witnesses to prove the truth of the fact, and this the Chief Justice (Pemberton) allowed to the fullest extent. The medical testimony is as follows :—Two wounds were found on the body, within an inch and a half of one another. One went no further than the bone, having struck on a rib, and the other through his back. When the sword was drawn out blood followed. The neck was very flexible. The face was bloated, and the eyes blood-shot. And Mr. Lasinby, a surgeon, deposed to the marks on the neck as being very distinct, with a swelling above and below them. It is urged, in opposition to these striking facts, that Sir E. Godfrey was of a melancholy temperament, and laboured under a great depression of spirits ; that he probably destroyed himself under the operation of this feeling, and that the mark around the neck might be owing to the tightness of the collar." Beck considers this case as one of homicidal strangling, and we think properly. The sword wounds were doubtless inflicted after death.

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* In this case the tape was unbroken. Some of Tardieu's cases seem to show that a rope may break (slowly) after causing death, in cases of hanging.

Case IV.—*Disputed* Suicide or Homicide *by Strangulation.*

["Ann. d'Hygiène," 1829, 2, 447, Taylor, *loc. cit.*, tom. ii., p. 76.]

"A servant girl was found dead in her bed. Her body was rigid and lying in a constrained position with the face turned to the right, and there was a handkerchief so firmly tied around the neck that it was with some difficulty removed. A quantity of froth and bloody mucus escaped from the nostrils and mouth. The knot in the handkerchief, which was tied round the neck, was on the *left side*, as it is customary to find in left-handed people. The deceased was not left-handed, and there was no reason to suppose that she meant to commit suicide ; she went to bed the night before in her usual health and spirits. There was no mark of violence externally, but there were large patches of cadaveric lividity scattered over the skin, and a deep impression of a necklace on the skin of the neck, which had resulted, it was supposed, from the force with which the handkerchief had been tied. The neck appeared swollen, particularly on the right side. On opening the head, the vessels of the brain were found distended, especially on the right side, and on this side about half-an-ounce of blood was found extravasated. The tongue was pushed against the teeth. The lungs were gorged with blood. The examiners attributed death to strangulation, and in their judgment the act was not suicidal. One reason was that the handkerchief was tied in a *double knot*, and another, the absence of all motive. The College of Brunswick being appealed to by the legal authorities, concluded that deceased died from apoplexy, and they assigned as a reason for this the absence of a mark on the neck, but in this they were, as Dr. Taylor remarks, probably wrong—yet, after all, he concludes that the act was probably suicidal, because there were no signs of violence, or of disarrangement of dress. But, in our opinion, the girl may have been suffocated first, and the handkerchief tied afterwards,

Tardieu (*loc. cit.*, p. 191), gives a case on the authority of M. A. Rendu [" Ann. d'Hygiène," 1re série, 1833, t. x., p. 152] in which a girl, who had lost the use of her right hand from an old burn, strangled herself in her bed with a kerchief or shawl rolled into a cord, going round the neck two-and-a-half times, and fastened on the left side by two knots, the first of which was tighter than the second.

CASE V.—*Case of General Pichegru.*

[Chaussier, p. 279 ; Beck, *loc. cit.*, p. 579 ; Tardieu, *loc. cit.*, p. 159.]

" This distinguished soldier was confined in a state prison in the Temple [Paris]. On the 5th April, 1804, he was as well as usual, and at 10 p.m. the keeper locked the cell and took the key. The general was heard to cough during the night, but at 7 a.m., when they came to light the fire, he was found dead on his bed. A commission was appointed to examine the body, including several medical men. They found, twelve hours after death, a circular mark round his neck, about two fingers wide, produced by a black silk cravat strongly knotted, through which a small stick (18 inches long and 3½ inches in circumference) had been passed. This stick had been used as a tourniquet to produce the strangulation. One end of the stick lay under the left cheek, where, by an irregular movement of the body, it had caused a slight scratch. The face was ecchymosed, the tongue held between the teeth, the jaws fixed. The body was swollen, the extremities cold, and the muscles of the hands and feet were strongly contracted. The brain and its membranes were congested. The lungs were gorged, the stomach reddish. Chaussier and others justly condemn the imperfect reports of the medical examiners, so different from the usual rather diffuse French reports. " No human eye," says Sir Walter Scott, " could see into the dark recesses of a state-prison ; but there were not wanting many who entertained a total disbelief of Pichegru's suicide." Napoleon's denial of it at St. Helena may be true so far as his own personal complicity is concerned.*

CASE VI.—*Murder by Strangulation on board ship ; a rope afterwards tied round the neck.*

[Beck, *loc. cit.*, 577, also noticed by Taylor and others. Hargraves' " State Trials," vol. vi., pp. 816, 831 ; Croker's "Boswell," vol. i., p. 332.]

Sir John Dinely Goodere in 1741 was forced by violence on board the *Ruby* [commanded by his brother, Captain Goodere, who was said by some to be insane], and lying in the port of Bristol. In the night Sir John was strangled by two assassins in the pay of his brother. One of these confessed that the other fell on Sir John as he lay in bed, took hold of his throat with his hand (his stock being on), and so strangled him with his own stock. They then put a rope, with a noose in it, round his neck, and drew it tight, to insure the certainty of the murder. In accordance with this, Mr. Dudgeon, the surgeon's mate of the *Ruby*, swore that there were some marks on the neck, which looked like the scratching of nails, while blood came out of his nose and mouth."*

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* Napoleon's words are :—

" Pichegru fut trouvé étranglé dans son lit. On ne manqua pas de dire que c'était par mes ordres. Je fus totalement étranger à cet événement. Je ne sais pas même pourquoi j'aurais soustrait ce criminal à son jugement. Il ne valait pas mieux que les autres, et j'avais un tribunal pour le juger et des soldats pour le fusiller. Je n'ai jamais rien fait d'inutile dans ma vie."—*M.S. de Sainte Hélène.*

Other noteworthy cases.—In Casper, Beck, Tardieu, and Taylor, many other remarkable cases will be found. We may refer especially to the "*Affaire Armand et Maurice Roux*," tried before the Court of Assizes of the Bouches du Rhône in March, 1864 [Taylor, *loc. cit.*, p. 79 ; Tardieu, *loc. cit.*, p. 230-248 ; Paris, 1864 ; "Ann. d'Hyg.," 1864, 1, 415], in which a servant man, in the prime of life, accused his master of trying to strangle him. The accuser was found almost senseless, and nearly lifeless, in a cellar, hands and feet both tied. M. Armand was very properly acquitted, partly because the servant pretended that he had been in the cellar eleven hours in this condition, and the limbs were not swollen where ligatured, though tightly tied. Then again the cord round the neck was not half so tight as a would-be murderer would have made it.

Also to mistakes as to putrefaction, in the cases of Mrs. *Ellen Byrne* (Dublin, Aug. 1842), and *Reg.* v. *Mahaig* (Kingston Winter Assizes, 1863, see Taylor, *loc. cit.*, p. 65).

And to *Dr. Campbell's* case, in which there was a fracture of the (ossified) larynx, and marks in the throat of an old man found dead, which, from their peculiar form, were clearly produced by a *left-handed person. The prisoner, on being asked to throw a stone, did so with his left-hand!* He was, however, acquitted, although his sister swore to witnessing the act, on account of her notorious bad character. See also *Dr. Keeller's* case, "Edin. Med. Journal," Dec., 1855, p. 527.

In one of the cases recorded there was only the mark of *one thumb* on the throat, and the murderer afterwards confessed this to have been the means. Beck (*loc. cit.*, p. 581) gives the case of a coloured man, Frederick L. *Terge*, who was a drunkard, and found dead in a gutter, who is supposed to have been *strangled by the tightness of his own shirt-collar.* There were marks of a thumb and three fingers, which do not seem to have been compared with the hand of the deceased, as they should have been.

Some of *Casper's* cases (contained in vol. ii. of Dr. Balfour's translation) show that *laceration of the carotids may be produced in the "post-mortem,"* if the operator use any force in pinching the artery, either with forceps or fingers. To avoid this the sheath should be carefully opened, the artery severed above and below by a sharp instrument, and then laid cautiously open.

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* Dr. Smith justly remarks that in cases like the last, where struggles may have been made, and thus some aëration of blood has gone on : that is, in manual strangulation, the congestion of the lungs and brain, and of the venous system generally, may be less marked than in cases where a cord is suddenly drawn tight round the neck. [Smith, John Gordon, M.D. "On the Principles of Forensic Medicine," London, 1821, p. 229.]

Death by Suffocation.

This is a very ancient method of *murder*.

An example will be found in the 8th ch. of the 2 Bk. of Kings, v. 15—"And it came to pass on the morrow that he [Hazael] took a thick cloth and dipped it in water, and spread it over his [Ben-hadad's] face, so that he died: and Hazael reigned in his stead." Ben-hadad being, as we are informed by the context, already very ill and not expected to live. Feeble persons, young persons, very sound sleepers, and epileptics, may (occasionally) be suffocated accidentally by very soft pillows, or in the case of epileptics, by falling on soft mud, heaps of feathers, hay, rags, and similar soft substances. The same might happen to a drunken man or woman. A great many cases of accidental suffocation in young children, occur on Saturday, Sunday, and Monday nights, or more rarely on public holidays. These infants sleep in the same bed as their father and mother, who generally state that they woke up and found them dead. It is to be feared that in too many of these cases the parents are drunk on retiring to rest. In a few it is to be feared that no care is taken to prevent such an accident, but that it is rather welcomed, as such children are sometimes found to be entered in two or three *death* [or rather *burial*] *clubs*. The pressure of the mother or other parent's body is usually the cause of death. We have already warned you not to expect great congestion of the lungs in some of these cases [see p. 919]. Sometimes the child slips down under the bed-clothes. Burke and Hare used pitch plasters over the mouth, in order to get subjects to sell to the surgeons for dissection! But these means were supplemented by pressure on the chest, compression of the nostrils and throat, &c. The taking of plaster of Paris casts of the face, without inserting tubes into the nostrils has several times nearly proved fatal. Negroes have been said to *swallow their tongues*, in other words, to double them back, and draw them into the throat, in order to commit suicide. This seems doubtful. Children do, however, sometimes suffer from a kind of convulsion, which produces this effect [and may perhaps die of it]. Such a case was recently brought to the N.E. Children's Hospital, but recovered when the diet was changed, and bromide of potassium was given at the same time. Would be suicides thrust shawls, portions of paper, or of their clothing, pocket-handkerchiefs, &c., into their mouths. But foreign bodies are also introduced by murderers. Smothering in crowds [see 2 Kings, vi., 17] too often happens on occasions of public rejoicing, and in panics of fire, &c., in churches and theatres. The mechanism is generally by direct pressure on the thorax. *Blood* from the nose, or from wounds in the throat or mouth, may thus suffocate, and the bursting of an aneurism into the windpipe or a bronchus would tend to kill in this way. In cases of *cut throat*, when the windpipe is jagged or completely divided, a sort of valvular closure, and a drawing-in of the lower end into the throat sometimes occur. *Scalds of the glottis, and the application of irritants* to the fauces or glottis produce œdema of the glottis, which causes suffocation. [Dr. Taylor gives a case from the application of acid nitrate of mercury to the throat, *loc. cit.*, p. 82.] The bursting of a *pharyngeal abscess* (as in quinsy) of post-pharyngeal abscesses, the pressure of fatty and other tumours, *œdema of the glottis* from kidney disease, scrofulous glands, *the presence of vomited matters in the air passages*, or of foreign bodies accidentally swallowed (bread, bits of bone, pins, nails, coins); a half-sovereign proved nearly fatal to Mr. Brunel), beans, the knob of a teapot, large bits of beef or potatoe, and even an oyster) have thus caused death.* Dr. Taylor states that sixty deaths from suffocation by food were registered in England in the year 1870.

Diphtheria, and some other diseases, cause a more or less complete paralysis of the muscles of deglutition, which may predispose to the occurrence of this accident. Dr. Behrend reports a case in which roughly treating a drunken man (by violence to his abdomen) caused him to vomit, and the food got into the air-tube. [Horn's "Vierteljahrsschift," 1868, 1, 123.] Dr. Taylor quotes from Dr. Littlejohn a case in which he found a quart-bottle cork, with the sealed end uppermost, roughened by the corkscrew, inserted tightly into the upper part of the larynx of a woman. *Her ribs also were factured.* The defence, that in drawing the cork with her teeth it had been suddenly forced or drawn into the windpipe was negatived by the sealed end being uppermost, by the marks of the corkscrew, by the structure of the parts, &c. The medical opinion was that the cork had been forcibly put into the windpipe whilst she was dead-drunk. Five persons were with her at the time of her death, but as it was not possible to fix the crime on any one the Scotch verdict of "Not proven" was very properly returned. "Edin. Med. Journal," Dec., 1855, p. 511, and p. 540. In *Regina* v. *Spawl* [Central Crim. Court, September, 1872], a man was charged with causing the death of a child by administering to it a large quantity of *pepper*. The medical evidence showed that death resulted from suffocation, as the air-passages were choked with pepper. It was said that the top of the pepper-castor came off, so that about half an ounce of pepper had found its way into the child's throat, &c. The prisoner was convicted of manslaughter.

As to the time required to kill, the experiments of Monsrs. Faure, Casper, and of the Medico-Chirurgical Society, as well as others related by Tardieu and other authorities, make it probable that death occurs in from two to five minutes on an average. In dogs (some nine experiments are related in the "Med. Chir. Trans.," 1862, vol. xlv., p. 454) it was found that respiration ceased altogether in about four minutes five seconds, *the heart continuing to beat some three minutes fifteen seconds more.* This was when all access of air was excluded. The longest period after which recovery took place was complete stoppage of respiration for three minutes and fifty seconds. When a little more than four minutes (less than five), were so spent, no dog recovered. The sooner air was readmitted, the more rapid, naturally, was the recovery.

Principles of Treatment.

These must be identical with those previously mentioned under Hanging, Drowning, and Strangulation. [See especially, p. 937.] The details only differ somewhat. Your first care must be to explore the mouth, &c., and to clear the air passages and pharynx. Introduce your finger into the mouth. Sometimes suction, by some instrument like the Higginson's syringe adapted to a trachea tube, might be advantageously used (as in the pepper case just mentioned), or you might endeavour to excite sneezing by irritating the nostrils [by snuff, a pin or needle, ammonia, &c.], or coughing, by irritating the glottis ; cold affusion, and artificial respiration, perhaps galvanism, or venæsection, chafing the limbs, the application of heat, stimulants cautiously given by mouth or rectum, one and all may find a place. It is natural to suppose that *oxygen* gas would be a good remedy for what is essentially a poisoning by CO_2, or want of oxidation. But pretty as is the theory, it is seldom found practical. Oxygen gas takes time to prepare, whilst *atmospheric air* (one-fifth of which is oxgen) *is always at hand.* Further, there is reason to believe that it is not always safe to use oxygen pure and undiluted. The authors know of one case in which apoplexy appeared to be induced by it, in a case of cardiac disease. *Whatever else you do see that there are no obstacles to respiration.* In the case of foreign bodies, or in dyspnœa of doubtful origin, it may be necessary to do tracheotomy or laryngotomy.

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* A case told me by M. Pomian, a Russian physician, shows how careful we should be in drawing conclusions. A Russian sentry on guard was found dead in his watch-box, with a large piece of meat in the lower part of the pharynx, pressing upon, and partly covering, the glottis. His death was therefore supposed to be accidental. Some years after, his superior officer, in dying, confessed that he had first suffocated the man, and then placed the piece of meat in his throat, in order to divert suspicion from himself.

Post-mortem Appearance.

These are (*par excellence*) those of death by apnœa (asphyxia). See p. 918.

There may be patches of lividity and dotted or punctiform ecchymoses on the skin [Tardieu, *loc. cit.*, p. 254, &c., and " Ann. d'Hygiène," 1866, 2, 346]. There is lividity of the lips, and extremities ; the face may be pale or violet ; it is often placid, especially in accidental cases. The eyes are congested. There is a mucous, sometimes blood-stained, froth about the mouth and nose. The lungs and heart, especially its right side, may be gorged with dark fluid blood. But, as stated elsewhere, the lungs of young persons and children may be comparatively small, *almost bloodless, and more or less emphysematous,* the air vesicles being broken down, one into the other. M. Tardieu (supported by M. Causse *d'Albi* and others) lays very great stress upon the existence of *punctiform sub-pleural ecchymoses.* He has figured these in coloured plates at the end of his work on Death by Suffocation, and also in that on Infanticide. They are of a dark colour, varying from the size of a pin's head to that of a small lentil [d'une téte d'epingle, jusqu'à celles d'une petite lentille] on the lungs of new-born infants, and in similar proportions, though rather larger with adults. There may be only five or six, or there may be enough to give a granite-like aspect to the lungs.

The pericardium, peritoneum, mucous membranes, and the interior of blood-vessels, may display similar extravasations, which are sometimes stellate and irregular. Mons. Tardieu considers these *the special signs of death by suffocation,* though not necessarily of murder, since he admits they may be present in still-born infants. He has found them ten months after the death in a child whose body was found in night-soil ! As regards the emphysema, mentioned above, consult *Prus* [" Trans. Méd.," Oct., 1832, and " Mém. de l'Académie de Méd.," Paris, 1843, tom x., p. 655, *Devergie* (" Ann. d'Hygiène," &c., 1832, 7, 310, and 25, (1841), p. 442). *Oznam* (" Arch. Gén. de Méd.," Jan., 1854). Other authorities will be found in Tardieu (note to page 258, *loc. cit.*). Under the hairy scalp in the periosteal cellular tissue, there will often be minute extravasations [Durand-Fardel]. Dr. Ogston and others will not allow that the occurrence of these punctiform ecchymoses is uniform in cases of suffocation, and they have found them in other modes of death. *The blood is very fluid and dark,* hence wounds will bleed a long while after death. The stomach and other intestines are often much congested.

It will thus be seen that there are very few appearances in the dead body which are absolutely characteristic of death by *suffocation.* So that our answer to the question, *Did the deceased die of suffocation?* must often be that there is no absolute proof of this mode of death in the particular case. The next question, *Was the death suicidal, accidental, or homicidal?* is often more easy to answer. Suicide by this method is rare: when done at all, it is usually by stuffing rags, paper, or articles of clothing into the pharynx. It is scarcely possible for a man or woman to kill themselves by holding their breath, except under water, or some thick fluid. Dr. Taylor quotes cases of suffocation by suicides using rags, &c., from the "Edin. Med. and Surg. Journal," April, 1842, Ibid., vol. 54, p. 149, and "Med. Chir. Review," vol. 28, p. 410. Others will be found in Beck and Tardieu.

But although a child of ten or twelve might *possibly* thus commit suicide we may be sure, in the case of an infant, that death has resulted either from *accident* or *murder. Marks of a coarse cloth, or sheet over the mouth, foreign bodies in the mouth, nostrils, throat, and air-passages;* and the discovery of the body in a box, linen press, water-closet, cesspool, heap of bran, and the like, would suggest the latter. Whilst accident is possible when a child is born, the mother being alone and unassisted, from her fainting and the child being born into blood or ordure. Also in the cases of children overlaid in the small hours by drunken or very tired and deep sleeping parents. Also when children are given an *artificial teat* of rag or leather to suck. Dr. Taylor shows, however, that this practice is probably sometimes done with a will to murder as if by accident. [As in the Warwick Workhouse, *Reg.* v. *Cox,* Warwick Lent Assizes, 1848. Taylor, *loc. cit.,* p. 92, vol. ii.]

Under the heading of death by

Smothering.

Dr. Taylor alludes to the death of children by *over-laying,* of which, according to the Registrar-General, *almost one case a day happens in London alone!* whilst in Liverpool in 1864 it appeared that out of 960 inquests, there were 143 on infants and young children who had been suffocated chiefly between the Saturday and Monday of each week!

The authors are of opinion that whenever a verdict of death by this means is recorded, and there is and can be no proof of intent to murder, some punishment in the shape of a fine or a public censure should be inflicted on the parents. In order also to check the temptation to murder in this way, they think that it should be made illegal to enter infants or children under age in any death or burial club, and that life insurance should not be allowed to commence until the age of twenty-one. The horrible crimes of *Burke* and *Hare,* and *Macdonald,* and of Bishop and Williams (1828 to 1831, in Edinburgh and London) done to get money for the bodies of the victims, by selling them for dissection, led to the passing of what is known as

The Anatomy Act

in 1832, by which the unclaimed bodies of persons dying in hospitals, workhouses, and other public institutions, may be utilized for anatomical purposes. By this Act an Inspector of Anatomy is appointed, under the control of the Secretary of State; and in the hands of this inspector are placed the charge of giving licences, and of providing for the decent interment of the remains. For an account of the horrible events which led to the passing of this Act, see Taylor, vol. ii., p. 94-97; Beck, p. 585, and elsewhere; Guy, *loc. cit.*, p. 283, and most encyclopædias, Art. *Burking*; also the medical and general Journals, of 1826-1832.

We have given several illustrative cases of these under Infanticide, p. 804 to 810, and shall therefore not take up more space by quoting others, but simply refer to one or two cases of some special interest.

In reference to the case of *Campbell*, for whose murder by suffocation *Burke* was condemned and executed in 1828-9, Dr. Christison remarked "that the lungs were remarkably free from infiltration, and although the blood in the heart and great vessels, as well as throughout the body, was fluid and black, yet the conviction in the public mind, that a well-informed medical man should always be able to detect death by suffocation, simply by an inspection of the body, and without a knowledge of collateral circumstances is erroneous, and may have the pernicious tendency of throwing inspectors off their guard, by leading them to expect strongly-marked appearances in every case of death by suffocation. That such appearances are very far from being always present ought to be distinctly understood by every medical man who is required to inspect a body, and give an opinion of the caase of death." ["Ed. Med. and Surg. Journal," vol. xxxi., p. 239.]

In the case of *Carlo Ferrari*, suffocated by Bishop and Williams, the lungs were not congested, and the heart was small, contracted and empty. See also the case of *Reg.* v. *Norman*, C.C.C., July, 1871, quoted by Taylor, *loc. cit.*, p. 94, in which a girl aged fifteen was tried for murdering four children by suffocation. One boy, a lad of ten, was heard to cry out, and this caused her crime to be discovered; she had just killed one child aged fifteen months!

DEATH BY POISONOUS GASES.

Suicide by burning charcoal [generating a mixture of carbon monoxide and carbon dioxide CO, and CO_2, according to the amount of air], is a favourite method of self destruction in France. Death by gases is usually accidental in England, either from faulty stoves, the escape of sewer gases from chemical works, discharging acids into sewers, or from the escape of coal-gas. Most of the poisonous gases have already been described. See *Chlorine*, p. 83, &c., and the chapter on Gaseous Poisons [Chap. xvii., pp. 550 to 579]. Only a few of these are known to produce definite chemical compounds with the colouring matter of the blood. See on this point "Die Blut-Krystalle," von W. Preyer, Jena, 1871, and numerous papers by Hoppe-Seyler, Sorby, and others, in German and English medical journals from 1840 up to the present time. Preyer gives a good Bibliography up to date (1871).

It may be said in general terms that whenever we suspect death to have occurred from poisonous gases, the majority of which act rather by excluding oxygen, than by direct toxic effect, our principles of treatment must be :—

1st. To promote respiration and the oxidation of the blood by a free supply of air, and by artificial respiration.

2nd. To keep the heart going, and to relieve venous congestion, as in cases of apnœa.

3rd. Not only to obviate the immediate tendency to death, but to watch and combat the after effects, which may develop themselves ; and especially to guard against either death from shock or from excessive reaction, so far as lies in our power.

Death from Anæsthetics.

Chloroform, ether, nitrite of amyl, bichloride of methylene, and other anæsthetics, have been described, with their effects, in Chapter XV., pp. 497 to 534. We only mention them again to remind you that there is more and more reason to believe that the action of the vast majority of them, including nitrogen monoxide or laughing gas, used by dentists, is rather due to the privation of atmospheric air, than to any peculiar or toxic effects of their own. It is true that chloroform and ether, and some others of these bodies, may form fresh compounds with the blood-colouring, and may be partly decomposed in the lungs, and perhaps even partly digested in the alimentary canal; and new and poisonous compounds, such as *formic* acid, are doubtless formed in some cases [chloroform, hydrate of chloral, croton-chloral, &c.]. Some of them are supposed to act by paralyzing the heart. Chloroform is considered by many as far more dangerous than ether, for this reason. One remark, however, applies to the whole group of anæsthetics. That is, that no anæsthetic has yet been discovered which has not given rise to fatal cases as soon as ever its use became general ; although some, like ether, are safer for long operations ; and others, like nitrous oxide (N_2O), or laughing gas, have given rise to very few casualties, because only used for brief operations (as extraction of teeth). All of them should be administered with great caution, and whenever possible, the chloroformist, etheriser, or administrator of the anæsthetic, should have nothing else to do. Assistants should be at hand to help in artificial respiration, &c. The moment danger is observed, doors and windows must be thrown open, the anæsthetic removed, the tongue and lower jaw drawn forward, and artificial respiration, and other means for restoring suspended animation (see pp. 923 and 937) at once resorted to. Dr. Brown, of Haverfordwest, and Nélaton both urge (in cases of chloroform and ether poisoning) that the head should be held downwards for a little while, to restore the cerebral circulation. Acupuncture to the heart, galvanism to the heart and to the phrenics, cold affusion and other adjuncts to artificial respiration ; and the injection of stimulants into the rectum ; with saline injection into veins, or transfusion of blood in cases where much blood has been lost, have all their advocates and their advantages. [See the last volume of Ziemssen's "Cyclopedia of Medicine," on Poisons, &c.]

The effects of Impure Air, Ochlectic Poison. The spread of Contagious and Infectious Diseases.

Some of the effects of impure air have been considered under the heading of *Poisonous* Gases. See especially, pp. 552 to 570. At page 554 the requirements of the Poor-law Board are stated as to cubic space. In hospitals for contagious diseases nothing less than 2000 cubic feet of space for each *patient* can be considered sufficient. 800 cubic feet *per child* is demanded by the Educational Department for Schools. This subject is rather a branch of what is called Hygiène or Preventive Medicine, than of Forensic Medicine, properly so-called. Yet the rue and other herbs still laid before the judges at assizes testify to the necessity of preventing overcrowding in gaols and elsewhere, since the neglect of this precaution caused *typhus fever* to be so prevalent in old times that there was scarcely ever an assize but the fever had its victims amongst the members of the legal profession; and the herbs were thus placed with the hope of warding off contagion. The gases enumerated [carbonic oxide and dioxide, hydrogen sulphide, sulphurous acid, &c.] are by no means the only gases found in the air of crowded rooms. There are subtle animal poisons, some of which are only recognisable by their effects; probably compound ammonias, and cyanogen compounds, which tend to generate and spread diseases. The term *Ochlectic* [from ὀχλέω to disturb by a mob or crowd, or from ὄχλος a crowd itself] has been invented as a general term for these.

The massing of numbers of people together also tends to the spread of other zymotic diseases, such as scarlet fever, whooping cough, measles, smallpox, &c. Recent legislation has made the transport of sufferers from known contagious or infectious diseases in ordinary carriages, and the letting of lodgings recently occupied by such, unless thoroughly disinfected, misdemeanors punishable by fines, the withdrawal of licenses, &c.

All these subjects are treated of in Manuals of Hygiène. You may, however, be asked two questions on these points :—

1st. *How is the contagion or infection propagated?*

2nd. *How long does the contagion or infection last?*

In answer to the former you must reply that for most of the so-called zymotic diseases there are several ways in which the disease is spread from person to person, as for example :—

(1) By direct personal contact with the living or dead body of one already diseased, as in the case of children or adults sleeping together, or nurses handling the sick, or (in some cases) by medical men using the manipulations necessary for treatment or diagnosis.

(2) By contact with the *excreta* of the sick, including

(*a*) Particles of the epidermis or cuticle (scarlatina, measles, erysipelas, &c.).

(β) Particles of moist or dry pus, "matter," or "scabs," and crusts."

(Porrigo, variola, vaccinia, &c.)

(γ) Portions of coughed-up or expectorated matter.

[The sputa of diphtheria, croup, phthisis, [?] whooping-cough, and glanders.]

(δ) The *nasal* secretion [glanders, &c.]

(ε) Portions of vomited matters.

[Yellow fever and the plague (a severe form of typhus, with buboes).]

(ζ) Contact with the fæces and urine.

[Cholera was spread by the dejections when a few hours old—when quite fresh, and again after a few hours, the fæcal matters failed to propagate the disease—*Pettenkofer*, *Burdon-Sanderson*, &c. Typhoid or enteric fever probably spreads in this way.]

(η) Contact with other fluids and secretions; blood, saliva, and milk, perspiration, leucorrhœal and vaginal discharges [syphilis, gonorrhœa, some forms of stomatitis, measles, puerperal peritonitis, &c.]

(3) By soiled clothes, bedding, and books used by the sick.

(4) By the presence in the air of sick rooms, of sick houses, and even of infected towns, of *fomites* or other media of contagion—gaseous, liquid, or solid—experiments on vaccine lymph incline modern medical men to believe that the contagion generally exists in the form of solid particles, which can be separated by filtration.

(5) By food and beverages, as by water previously contaminated in any of the ways mentioned above.

Your reply to the second question must be cautiously worded. Unless clothing has been subjected to a dry heat of from 212° to 300° Fahrenheit [100° to 149° C.] or more; or thoroughly washed with disinfectants and then dried, or exposed to chlorine or sulphurous acid gas; and unless rooms have been treated by the same gaseous disinfectants, or thoroughly cleansed with hot water and soap, and exposed for some days to free currents of air, infection will linger lovingly in some fold of the clothing, or in the dust of the apartments.

As regards patients you must be still more cautious. The stools of patients convalescing from enteric fever appear to be capable (if not disinfected) of spreading the disease for two or three months. A scarlet fever or measles patient will spread the disease at least until his or her skin has completely ceased desquamating. A variolous patient, at least until every particle of scab has been removed from his skin.

Peroxide of hydrogen or ozonic ether is said by Dr. Day of Geelong to check this tendency of scarlet fever and smallpox to spread from person to person. He uses it in the form of an ointment [rubbed up with lard.]

Itch is spread by the insects (*acari*) or their ova being transferred from one person or article of clothing or furniture to another.

Ringworm and allied diseases by the *fungi-sporules* in hair, hair-brushes and combs, or on articles of clothing, and by contact of head with head, &c., or by the contact of caps, bonnets, pillows, and the like already contaminated.

Syphilis is spread by sexual intercourse, by syphilitic discharges, by drinking-vessels, and pipes (used in smoking or glass-blowing), by wet-nursing, and more rarely in other ways [see pages 719-20, under Malapraxis].

Gonorrhœa, in similar ways to syphilis.

Intestinal worms are propagated—(1) By the use of tank, well, or river water, which has (by the admixture of fæcal matter or sewage) been made to contain the *ova* of these parasites. One joint of a tapeworm has been said to contain more than 70,000 eggs.

(2) By the use of raw or imperfectly cooked meat containing the ova, or immature forms of the parasite [*measley pork*, sausages, &c.]

(3) Possibly by the use of waterclosets and privies being common to those suffering from worms, and to healthy persons.

(4) Raw vegetables (salads, watercress, &c.) grown on sewage farms, or contaminated by animals, and imperfectly washed, are supposed to spread these parasites, and very probably do. The popular notion of *unripe* fruit (per se) spreading them, is however untenable.

Of the Impurities met with in Water, and their consequences.

This subject again relates rather to Hygiène than to Forensic Medicine, but may be, and often is, the subject of legal proceedings, as in the case of paper-mills, dyeing and bleaching establishments, chemical works, &c.

You are already aware that except in the case of water prepared by synthesis from chemically pure materials, such a thing as absolutely pure water is quite unknown. Even distilled water and fresh rain-water contain some ammonia, carbonic acid, and other matters which detract from their purity, whilst the best river, well, pond, tank, and other waters, contain a large number of chemical compounds, chiefly salts.

For practical medico-legal purposes, however, we may divide the important impurities of water into two or three categories, as for instance :—

I. Impurities which detract from the use of water for washing.

On this subject we must refer you to special technical works*. You should, however, know that very *hard water, particularly if the hardness be permanent* † is wasteful (as regards soap).

II. Impurities which make water disagreeable rather than dangerous when used for drinking or domestic purposes.

Under this heading chalybeate, sulphurous, and most medicated or mineral waters would naturally be included.

III. Impurities which make water dangerous or undesirable to be used for drinking or domestic purposes. Of these we have—

(1) Certain mineral impurities, such as a large proportion of chlorides, nitrites, nitrates, &c., which, though themselves not specially harmful, may indicate contamination with sewage or decaying animal and vegetable matters.

(2) Poisonous mineral constituents ; lead, arsenic, antimony, and

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* Sheridan Muspratt's "Chemistry," Sutton's "Volumetric Analysis," Ure's and Watt's Chemical and other Dictionaries, Encyclopædias, &c.

† A *hard* water is one containing much mineral matter (chiefly lime salts), which *curdles*, and wastes the soap used in washing with or testing it. Dr. Clark (of Aberdeen) devised a soap-test, the degrees of hardness being measured by the quantity required to make a permanent *lather*. *Temporary* hardness is that due chiefly to bi-carbonate of calcium in solution, and is removed by boiling ; *permanent* hardness is due chiefly to calcic sulphate, &c., and is *not* removed by boiling.

barium compounds are the most probable of these; derived from manufactures, or from the constitution of the soil through which the water percolates.

(3) Decomposing animal and vegetable matter usually indicated by the smell, colour, and taste, or by permanganate of potash and other reagents.

(4) Deleterious gases, vapours, and solid particles, derived from sewage, grave-yards, &c.

Infusoria, fungi, hydrogen sulphide, and other gaseous compounds of sulphur, phosphorus, carbon, and hydrogen come under this heading.

The principal consequences of drinking impure water are :—

(1) Acute and chronic poisoning in the case of water containing lead, arsenic, barium, &c.

(2) It is said that diarrhœa, cholera, dysentery, typhoid fever, septic poisoning, premature calcification of arteries, and of the cartilages, and muscles (as of the heart), and probably many obscure diseases, possibly diphtheria and other diseases of the alimentary canal—gravel, sand, and other renal diseases—originate in this way. It must be confessed, however, that much of the so-called evidence is hypothetical.

CHAPTER XXIX.

Death and other Injuries due to Lightning—Effects of great Cold—Frost-Bites—The effects of extreme Heat—*Coup de Soleil*—Burns and Scalds—Spontaneous Combustion—Starvation, acute and chronic.

The number of deaths by lightning varies greatly in different years. Nor is this remarkable when we consider that there are more electric storms in some years than in others, and that a variety of events must coincide in order that death may result from this means. The human body is generally considered to be a bad conductor of electricity. As regards living muscles, which constitute a large part of the human body, Ranke considers that their conducting power is 3,000,000 times weaker than that of mercury, and 15,000,000 times below that of copper [Brown-Séquard in "Proc. Roy. Soc.," No. 44]. If we judged only from such statements, we should imagine that human beings would seldom perish from lightning. Yet no year elapses without its quota of deaths; and it would appear that about twenty persons are thus annually killed in England and Wales alone. As might be supposed, most of these deaths occur out of doors. "It is not known," says Fownes, in his "Chemistry," "to what cause the disturbance of the electrical equilibrium of the atmosphere is due. Experiment has shown that the higher regions of the air are usually in a *positive* state, the intensity of which reaches a maximum at a particular period of the day. In cloudy and stormy weather the distribution of the atmospheric electricity becomes much deranged, clouds near the surface of the earth often appearing in a *negative* state. The circumstances of a *thunder storm* exactly resemble those of the charge and discharge of a coated plate or jar; the cloud and the earth represent the two coatings; and the intervening air the bad conducting body, or *dielectric.* The polarities of the opposed surface and of the insulating medium between them become raised by mutual induction, until violent disruptive discharge takes place, through the air itself, or through any other bodies which may happen to be in the interval" [as, for example, a human body.] "When these are capable of conducting freely, the discharge is silent and harmless; but in other cases it often proves highly destructive. These dangerous effects are now in a great measure obviated by the use of *lightning-rods* attached to buildings, the erection of which, however, demands a number of precautions, not always understood or attended to. The masts of ships may be guarded in like manner by metal conductors. Sir W. Snow Harris has devised a most ingenious plan for the purpose, which is now adopted with complete success in the Royal Navy." (*Loc. cit.*, pp. 95-6.) *Thunder* is a sound due to the sudden disturbance of the air produced by a lightning discharge; the long rolling effect is perhaps due to echoes from the clouds, perhaps partly to there being a number of discharges at different distances from the observer. Sound travels at about 1100 feet per second, whilst the passage of light is almost instantaneous;* therefore the thunder is heard some time after the flash is seen. *The interval in seconds divided by 5 or 4·8, gives the distance to the place of discharge approximately in miles. Lightning* itself is the spark or flash observed during a sudden discharge of atmospheric electricity. It may be—

(1) A diffused reddish white, or violet flash [sheet-lightning], seemingly spread over a considerable extent of the sky; perhaps due to a discharge inside the cloud, the light suffering reflection and diffusion. The *colour of the lightning* varies with the state of the atmosphere; in elevated regions, where the air is rare, the spark has a violet tint.

(2) A zig-zag line of light [forked lightning]; the path taken by the electricity in a discharge between two clouds, or between a cloud and the earth, is distinctly seen to be made up of straight lines and sudden bends. It resembles the discharge from the prime conductor of an electric machine; it is the path of least resistance, and seems to start from the positively electrified body: the light is very white and very brilliant.

(3) Heat lightning, as it is called. It is unlike (1) and (2) in being unaccompanied with thunder ["silent" or "summer" lightning], it seems to be the reflection from aqueous vapour and clouds, of a discharge occurring beyond the horizon, or it may be due to a discharge at such a great elevation in the atmosphere that the thunder cannot be heard.

Sometimes during a thunderstorm *fire-balls* are seen. No exact observations of these have yet been made; they are said to fall slowly (in about ten seconds) from the clouds to the earth, often rebounding once or twice, and exploding violently. It seems difficult to explain them on the supposition that they are of electrical origin. When the light of a lamp illuminates a rapidly-moving carriage-wheel, the spokes cannot be distinguished. This is due to the impression of an image on the retina of the eye, lasting for 1-10th of a second. When the wheel is illuminated by a lightning-flash, it appears to be motionless, therefore there is no perceptible motion during the time of the flash. Experiments with a revolving disc, with black and white sectors, show that a flash of lightning certainly does not last longer than 1-10,000th of a second. Water is a good conductor, dry air a bad conductor of electricity. Clouds consist of particles of water: these particles seem to owe their electricity partly to evaporation, and the friction produced by winds, and partly to other causes; their electricity is *generally positive.* The internal particles discharge into one another when they get condensed enough until the electricity reaches the outer part of the cloud. The *spectrum* of lightning shows the presence of incandescent nitrogen, oxygen, hydrogen, and sodium. It may be one or other of two species, according to the intensity of the discharge. If an unelectrified cloud comes near an electrified one, and if the first now lets rain fall, the rain may carry off electricity, and leave the cloud electrified. When the clouds get closer, or when one of them approaches the ground, a discharge takes place. Certain electroscopic experiments seem to show that previous to a discharge between two clouds, internal discharges are taking place in both. Lightning, in passing through air and non-conductors, metallic-rods, &c., exhibits all the phenomena of the passage of a very great quantity of electricity. It kills animals, splits trees and stones, and melts thin wires, buttons, &c. Prominent objects, buildings, trees, &c., afford a passage for the electricity; and if they are bad conductors, they may be destroyed; hence the use of lightning-rods, as mentioned above. Sometimes on entering the earth, the lightning melts the silicious substances in its way, producing the tubes called *fulgurites.* It possesses the power of magnetising iron and steel bars, and sometimes inverts the poles of magnetic needles. [Hence watches are sometimes stopped at a given moment, telegraph signals interfered with, &c.] After a lightning discharge the peculiar odour of ozone may be observed. Objects at a distance from the place of discharge may have previously been charged with electricity by the induction of the clouds; the distant discharge suddenly sets free this electricity, so that it passes through the objects to the ground, producing what has been called the *return shock.* Men and animals have often been killed in this way. If sparks are drawn from an electric machine when a frog is near, the frog experiences shocks of this kind. [This account is almost verbatim from the "Popular Encyclopædia."] If *lightning-conductors* are meant to protect a building, they must be sufficiently thick and massive, and must be as perfectly connected with the earth as possible. It is a good plan to connect the lightning-rod with the large water-pipes of the building, or carry it down deep into a well; and all outlying metal on the roof of a building should be connected with the conductors by strong wires, or wire rope, otherwise the wetted stones or bricks become tolerably good conductors of electricity, and will probably lead to the destruction of the building. [St. John's Church, Torquay, Chichester Cathedral, and St. Mary Overy, Southwark, are recent examples of damage to buildings.] "The conducting powers of different substances vary greatly. . . ." These bodies have been distinguished into groups as follows:—

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* The velocity of light is reckoned at about 185,000 miles per second. Wheatstone found the velocity of electricity through copper wire to be about 288,000 miles per second, whilst in the Atlantic cable of 1865 it was found to be only 3000 miles per second. ["Popular Encyclopædia."]

Conductors.	Semi-Conductors.	Non-Conductors.
Metals. Graphite. Solutions of Salts and Acids. Pure Water. Blood.	Alcohol. Ether. Dry Wood. Stone. Paper (moist) Ice at 0° (Cent.).	Dry Metallic Oxides. Fatty Oils. Ice at 25° (Cent.). Phosphorus. Dry Paper, &c. Wool. Silk. Gems, Glass, Wax. Sulphur, Resin, Amber. Gutta Percha and Caoutchouc. Shell-lac. Ebonite. Paraffin. Water-vapour (*i. e.*, dry steam). Gases.

This list is arranged for frictional electricity, and holds good for lightning; but as regards the galvanic current, we find that all conductors offer some resistance to the passage of the current, and that no body is altogether destitute of the power of conducting electricity. It is a question of degree.

Many mistakes have been made as to death by lightning. Thus even John Hunter appears to have been deceived by the transient and early post-mortem rigidity in some of these cases. Hence he asserted that *cadaveric rigidity* was absent in death from lightning.* We now know (and on this point the authors have personal experience) that rigidity does occur, and that the blood does coagulate, though the latter phenomenon is often slowly developed. Considerable light has been thrown on the phenomena of death by lightning, by the experiments of Dr. B. Ward Richardson [*see* "Medical Times and Gazette," May 11th, 1870] and Dr. Sedgwick, with the large induction coil at the Polytechnic Institution. The battery consisted of forty-eight Bunsen's cells, and was connected with an induction-coil of enormous size, weighing 15 cwt. Its primary coil was 3770 yards long, the secondary wire was 150 miles in length, with a central core or case of soft iron wire five feet long, four inches in diameter, and 125 pounds in weight. With this three kinds of sparks were obtained:—

1st. When the secondary wire was simply charged from primary wire and discharged, a spark of twenty-nine inches long, and of some thickness was obtained. It had two flames—a line of thin, blue, tense flame, surrounded by a thick burning flame; the latter could be blown aside by bellows.

2nd. When the break or vibrator was used, they obtained a spark ten to fifteen inches long, blue, intense, forked, and almost continuous.

3rd. When a Leyden battery (of forty square feet) was charged from this coil by three discharges, a most dangerous and fatal kind of artificial lightning was obtained. As regards the effects of the different sparks, Dr. Richardson showed that the *first kind* seldom injures much—it only singed the feathers or fur of pigeons and rabbits, and produced anæsthesia after several discharges. Thus a frog took twenty-five, a pigeon fifteen, and a rabbit thirty discharges, without being killed. It may even be sent right through the body. The *second* kind of spark is also pretty harmless if made on the outside of the body, but the contraction of muscles induced is more or less permanent. If passed through the interior of the body, the effects are more powerful, but death is seldom produced. When the *third* kind, from the charged Leyden jars is used, one or two discharges are found to be fatal if the current pass *through* the body, and is not stopped by feathers, &c. He notes that Franklin wrote thus in 1748: "A thin glass bubble, about one inch in diameter, weighing only six grains, half full of water, partly gilt on the outside, and furnished with a wire hook, gives, when electrified, as great a shock as a man can well bear." But even this kind has two effects, one non-fatal, on voluntary motion and common sensation; the other fatal (to respiration and circulation of living animals). Dr. Richardson concludes, as to lightning:—1st. That the kind of coverings with which the body is furnished makes a great difference. Fur and feathers are protective. Lightning kills by an *intense* shock like that of the Leyden jars. There are two kinds of shock, one produces temporary contraction of muscles, and insensibility (anæsthesia, and a sort of coma), and recovery is possible. The other kind kills outright. Lightning may or may not disfigure, or burn the clothes. John Hunter was wrong as to post-mortem rigidity being absent in death by lightning. But lightning does make the blood coagulate slowly in the body. There is a fourth kind from Leyden jars connected with positive and negative wires, which always kills, but does not mark the body, it kills in the same attitude as in life! [*See* the note to last page.] Animals not killed have lassitude, muscular wasting, great susceptibility to external motions, irregularity of movements (ataxia), and slow convalescence. He states that the

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* Hunter, like many other self-taught men of genius, was too apt to judge from *personal* experience only. Yet it is recorded before his time, in a letter of Pope to Lady Mary Wortley Montagu, that in July, 1718, two affianced lovers, John Hewett and Sarah Drew, were struck dead by lightning. The bystanders, he says, "first saw a little smoke, and after, this faithful pair—John with one arm about his Sarah's neck, and the other held over her face, as if to screen her from the lightning. They were struck dead, and already *grown stiff and cold* in this tender posture. There was no mark or discolouring on their bodies, only that Sarah's eye-brow was a little singed, and a small spot between her breasts. John was a well-set man about five-and-twenty, Sarah a brown woman of eighteen." [Lady Montagu's "Letters," vol. ii., No. 57.]

Signs of Death from Lightning Shock

are—

(1) Absence of all indications of movements of the heart.

(2) Absence of reflex action.

(3) Decrease of the temperature of internal cavities (chest, abdomen, &c.) to the temperature of water left exposed to the surrounding air.

(4) Absence of colour in semi-transparent structures (seen in hand, &c., by strong transmitted light).

(5) Rigidity of muscles.

(6) Coagulation of blood in veins.

(7) Decomposition.

The following *marks* of injuries from lightning have been recorded:—

A. *Marks of burning of the skin.*

B. *Ditto of the hair.*

C. *Impressions of metallic substances on the body* (coins, ornaments, seals, beads, crosses, buttons, &c.).

D. *Ecchymoses or vivid blue spots, with exudations of blood.*

E. *Arborescent marks* (*Tree-like impressions*). We shall mention these again.

F. *Loss of hair*, not immediate burning, but coming on afterwards.

His experiments lead him to believe that the *blood is a better conductor than water or muscle or nerve-matter* (whether grey or white) so that *the course of the lightning* and of electrical force through the body of an animal *is preferentially by the blood.*

Conclusions:—

1. The fatality of electrical or lightning shocks is in proportion to the *intensity* of the shock.

2. In those who are not killed, the reception of the shock is not remembered (accurately at least) owing to its instantaneousness. It is therefore *probably the most painless of deaths.* [He advocates its use instead of hanging criminals, also to kill animals for the table.]

3. Those discharges, which by their intensity, kill most readily, leave least marks of distortion or of external injury.

4. After what appears to be general death, the heart may continue to beat for several minutes.

The conclusions Dr. Richardson draws as to *markings and signs of death* have been given above.

Dr. Richardson remarks that *thin* chains, &c., may be melted, and thus mark more than thicker ones. The most noticeable sequelæ are (1) Reactive fever, or fever of reaction. (2) Apoplexy. (3) Convulsions and epilepsy. (4) Paralysis and anæsthesia or hyperæsthesia. (5) Catalepsy. (6) Blindness or injury to sight. The *pupil* may be *contracted* on the side of the shock and *dilated* on the other side."

It is but rarely that this mode of death or injury to property comes before our law courts. Dr. Taylor mentions a case tried in France in October, 1845, in which medical evidence respecting the character of wounds caused by electricity was of considerable importance. In August of that year some buildings at Malauny, near Rouen, were destroyed by a thunderstorm (said one side), or by a whirlwind (said the other). As the persons whose property was destroyed were insured against lightning, they sought to recover damages accordingly. The evidence as regards electricity consisted (1) in the alleged carbonised appearance of the leaves of some of the trees and shrubs growing near ; and (2) in the characters of the wounds on the bodies of several persons who were injured at the time. M. Lesauvage deposed to the occurrence of dark stains scattered over the bodies, and that the survivors suffered from torpor, pains in the limbs, and partial paralysis of motion. He also observed that those killed speedily putrified. In one case the muscles were torn across in a ragged manner, and some small arteries divided. M. Funel deposed that the face and neck in some of the dead bodies were bloated and discoloured, as if the death had occurred from asphyxia. M. Pouillet described the storm, but although he did not deny that there may have been thunder and lightning, he thought the trees and buildings were simply overthrown by the wind. But as Dr. Taylor remarks, it is unusual for young and green trees to present any marks of combustion about the leaves or trunk [*see* the "Comptes-Rendus," Sept., 1845]. The Royal Court of Rouen, without deciding the exact mode of the occurrence, condemned the insurance company to pay the amount claimed. [*See* "Law Times," March 14, 1846, p. 490, and Taylor, *loc. cit.*, p. 135.]

From the nature of their avocations, an overwhelming majority of the deaths from lightning are in the male sex, and happens out of doors. It is rare for persons to be struck dead in-doors, but the authors have known one or two railway signalmen and telegraph clerks struck by lightning in their offices. *The following places and things are considered dangerous during thunderstorms :*—Trees, masts, high poles, and lofty buildings unprotected by conductors, as for example, a spire or steeple, water, stove-pipes, walls, bell-wires and bell-handles, shutter-bars, iron pallisades, crowds of people, or droves of sheep or cattle, metal ornaments worn on the person ; umbrellas or walking sticks, with ferrules, tools of iron or other metal, particularly if pointed.* On the other hand, open places are safest, and a man is less likely to be struck when his clothes are well wet than otherwise. In addition to the *burns* and *wounds* produced by lightning [the latter lacerated punctures like wounds from a blunt dagger], Ambrose Paré and Pouillet speak of *fractures* of the skull and other parts. These are, however, very rare.

Careful study of the foregoing remarks and of the appended cases will enable you to answer most of the questions likely to be asked as to death or other injuries from lightning. Occasionally the passage of the electric current, when the tense spark has gone right through a limb, will be found to have drilled holes, just as paper is perforated at the Polytechnic by the same means. There may be burns, and hence blisters, when the flame is less fierce. The following cases and references, chiefly from Beck and Taylor, will further illustrate the subject.

Mr. Boddington and his lady, both struck by lightning. The injuries received by her were actual *wounds*, whilst his were only *burns*. Beck, *loc. cit.*, 522, "London and Edinburgh Philosophical Magazine," vol. i., p. 191. Another case with very *extensive burns* and *blistered skin*, "Edinburgh Medical and Surgical Journal," vol. xii., p. 493. One French and two German cases, in the latter, one with *livid streaks*, and one with extensive *burns*, "Lancet," N.S., vol. vi., p. 910, vol. vii., p. 255, 445. Case by Professor Stevens with extensive *vesication*, "New York Medical and Surgical Register," p. 55. Dr. Macauley reports three cases, one followed by *apoplexy*, and two by *epilepsy*, "Edin. Med. Chir. Trans.," vol. i., p. 360. Mr. Godfrey, "London Med. and Phys. Journal," vol. xlvii., p. 369, tells of a sailor struck dumb and blind. Beck states that *deafness* and *paralysis* are common results. The *pupils were dilated* in cases recorded by Drs. Young and Stevens, "American Journal of Medical Sciences," vol. xiii., 54. Beck refers to various vols. of the "Philosophical Transactions" for records of cases [*loc. cit.*, footnote to p. 522]. In vol. xlix. of these, p. 61, there is an account of the death of Professor Richman at St. Petersburg in 1753, whilst experimenting on atmospheric electricity. On the left side of the forehead, where he was struck by the electric current, there was a round *ecchymosed spot*. There were eight other patches of ecchymosis, of variable size, from the neck to the hip, chiefly on the left side. Some were *like marks of gunpowder* discharged in contact with the skin. The left *shoe was torn open* at the buckle, without being singed or burnt; but the skin around was slightly ecchymosed. Internally, a *quantity of blood was found extravasated* in the windpipe, the lungs, and the layers of the omentum. *The omentum appeared as if greatly bruised.* Dr. Taylor refers to Murbach's "Encyklopädie," article *Blitz;* and Henke's "Zeitschrift der S. A.," 1844, vol. i., p. 193, for further accounts of this case. A case by Lomonossoff is mentioned by Dr. Granville ("Travels to St. Petersburg," vol. ii., p. 112), in which there was only a *red spot on the forehead, the legs were blue, and one shoe was torn, but not burnt.* In a *non-fatal case*, the person seen soon after the lightning-stroke was found labouring under the following symptoms—*insensibility, deep, slow, interrupted breathing, relaxation of all the muscles, slow soft pulse, dilated pupils, the latter sensible to light* (Dr. Taylor from "Medical Gazette," vol. xiv., p. 654);

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* The following numbers express the conducting power of the metals named :—Lead, 1; Iron, 2·4; Zinc, 4; Copper, 12.

in other words, the symptoms of *concussion* of the brain. Slight shocks stun. Noises in the *ears, paralysis and other neuroses* succeed severe strokes ("Medical Times," July 15, 1848). *Insanity* is said to have resulted. [Conolly's Report of Hanwell, 1839.] In another case, three days *delirium* and *entire loss of memory* afterwards. ["Lancet," Aug. 3, 1839.] A boy aged four had *tetanus* for days after a lightning stroke, and died in four hours. ["Medical Times and Gazette," May 26, 1855]. Frontal headache, and *loss of sight,* which became total, occurred to an old man, who felt as if a vivid flash had struck him in the face, whilst standing under a tree. [*Ibid.*, July 24, 1858.]

Death is usually immediate; if not, recovery is the rule. But Dr. Taylor gives instances of death from the severe lacerations or burns indirectly produced. As in a case in London in July 1838. The same author mentions that three persons were struck by lightning. One of them aged twenty-six, an hour and a half after the stroke, lay completely *insensible,* as if apoplectic, his *pulse was below sixty, full and hard, pupils dilated and insensible, respiration snoring. Thumbs and jaws firmly fixed. Twitchings of arms and hands, then severe spasms, with the body drawn to the left side.* He was afterwards bled and blistered, and cold to the head, and sinapisms to the legs applied. Stimulant enemata and opium were given. He recovered consciousness in twenty-four hours, and soon got quite well. The only *external mark* was a *red streak as broad as a finger,* from the left temple extending over the neck and chest, disappearing completely in a few days. ["British and Foreign Medical Review," Oct. 1842]. These red streaks or marks sometimes resemble trees, or veins. See case by Dr. Horstmann in Casper's "Vierteljahrschrift," April 1863, p. 308. Also another in the "Australian Medical Journal," September 1870, p. 295. "In this case a youth was killed by lightning, and there were *contusions* on his left side, which was *extremely rigid.* His back *hair was burnt off. Both pupils were dilated. His nose bled from the left nostril.* The surgeon who examined him stated that he noticed on the *skin of the chest the perfect impression of a young tree, inverted!* of a dark colour, as if tattooed. It was just like the trees which grew near! When struck he had two or three layers of woollen cloth buttoned over his chest—his *cap was torn to pieces.* The *trousers on the left side were rent from the hip to the stocking*—the latter and the boot *were torn open. He died from injury to the brain.*"

Bodies often preserve the attitude assumed just before death. See note to page 969, and also "Medical Times and Gazette," February 18, 1860, p. 167. There are generally marks of the *entrance* and *exit* of the *electric fluid or current:* either a *severe lacerated wound,* or *a contusion,* or an *extensive ecchymosis,* or sometimes *a hole drilled or punched in appearance,* or like the stabs of a blunt dagger [Taylor]. Meyer says ecchymosis is most common on the back. *Several cases are given* by Taylor and others of *no external marks.* [*See* "Medical Times," May 3, 1845, p. 82, for several American cases]. *The clothes are nearly always torn,* and *partly singed, smelling of fire*—sometimes they are rolled up, and carried to a distance. *Metal buttons, etc., are often melted. Steel things become magnetised.* Dr. West told Dr. Taylor that he was called to a case in which a lad, aged eighteen, was killed by lightning, and his *pocket-knife had acquired strong magnetic polarity. His boots (full of hob-nails) were torn to pieces,* but his feet appeared uninjured. A friend of Dr. Taylor's saw a man instantaneously killed by lightning—*there was a hole in his cap, his hair was singed, his trousers torn, his shoes burst open. The woodwork of the building was merely split, and there was no mark of burning.* Dr. Taylor remarks that trees generally appear to be simply rent by the mechanical force. The authors, however, know of a rick burnt by lightning, of churches set on fire in the same way, and of an old tree (dry and dead many years) which was fired by lightning. In a non-fatal case, the wound in the thigh (says Dr. Taylor), was so deep as almost to bare the femoral artery. *The man was opening an umbrella*, a *practice often dangerous in such circumstances.* Dr. Mackintosh, of Littleport, was called in, May 1864, to see three persons who were struck twenty minutes before [Taylor, *loc. cit.*, p. 129; "Lancet," July 30, 1864, p. 118.] They had taken shelter under a hay stack, which had been set on fire by the same flash. No. 1. A boy of ten, had difficulty in moving his legs at first, pain in lower part of abdomen, *red streaks in chest and abdomen.* Recovered in about four days. No. 2. Aged eleven years, *had epileptiform symptoms*, and similar *red streaks, whilst his hair was singed at the back of the head and neck.* He became conscious in five hours, and rapidly recovered. No. 3. A man aged forty-six was killed on the spot—he was sitting, and had not moved. Rigidity came on 14 hours after. *He had a large lacerated wound of the scalp, dividing blood vessels and nerves.* His right ear *was livid and swollen.* There was a dark blue mangled patch of skin above the right collar-bone. His hair was singed. In his left trousers-pocket were lucifer matches and a tin tobacco-box, not affected, but a knife in his right pocket became magnetized strongly. In neither of these three were buttons melted or clothes torn. Their dress was very wet. The *burns* of the skin are sometimes ascribed to the clothes catching fire—sometimes correctly—but the electric fluid itself will inflict severe burns. [*See* Dr. Richardson's experiments.] Dr. Geoghegan met with the case of a girl struck by lightning, whose thigh and buttocks were burnt in first and second degrees, but her clothes were not burnt. Mr. Fisher of Dudley gave Dr. Taylor a case of a man milking a cow in a shed during a thunderstorm. The cow was killed at once; he was severely injured. It was a vivid flash. He was severely burnt from the right hip to the shoulder—nearly all the right side—but only the sleeve of his shirt was burnt; his arm was not injured. He had delirium and inflammatory fever (seventeen days).

Fleming describes eight cases. *Several were burnt severely, and their dresses much singed. Some were benumbed or paralysed more or less.* The burns took some months to heal ["Glasg. Med. Journal," Oct. 1859, p. 257.] Mr. Hill mentions *that a man was burnt by lightning on the nape* of his *neck, where a metal watch chain rested. From where the current left the chain the skin was blistered* in a straight line down to the feet, scorching the pubic hair. *He had paraplegia* [loss of motion and sensation] *and retention of urine, deafness, difficulty in articulation, dysphagia, and a metallic taste in his mouth.*

The anæsthesia passed away in half an hour, the retention in twenty-four hours, and the paralysis in four days.

In a case reported by Dr. Schaffer ["Oesterreich. Medic. Wochenschrift," June 6, 1846, quoted almost *in extenso* by Dr. Taylor, *loc. cit.*, p. 132], a healthy middle-aged labourer was working in a field with others, and imagined that the thunder-storm was over. He was trying to strike a light with a flint and steel when the lightning struck him. For a moment after the shock he stood still, and then fell heavily to the ground dead. The electric fluid had pierced and torn his hat at the upper part of his forehead; it seems then to have been divided into two currents, which passed down the sides of the body, along the lower limbs, and out at the feet. On the upper part of the forehead was found *a soft swelling of a dark blue colour*, about the size of the palm of his hand; the hair which covered it was uninjured. From this spot *two dark red streaks proceeded in different directions.* The left one, when it reached th left groin, formed a *large irregular scorched* (brandige) *patch*, and went on its way to the dorsum of the left foot, terminating in *several small dark blue* spots. The other streak, pursuing its way on the right, formed a similar burn or scorched patch in the right groin, and ended, like the other, on the foot. The hair of the forehead was not burnt, but the *pubic hairs were completely burnt.* This was ascribed to the buckles of an abdominal belt, which was completely destroyed. There was *extravasated blood* in the swelling on the head (about four ounces in all on the head). The *membranes of the brain were much congested, the choroid plexuses particularly so;* bronchi and air-tubes full of bloody mucus; the lungs greatly congested; the stomach and intestines the same; the right lobe of the liver and spleen were also much congested; not much blood in the heart and large vessels; beneath the burnt patches much blood was found extravasated amongst the abdominal muscles, *i.e.*, in their substance."

According to "Heller's Journal," Feb., 1845, p. 245, the hat and shoes of an old man killed by lightning were destroyed, but the garments were uninjured. *His left ear was severely lacerated. Black longitudinal lines were found on the skin of his abdomen, an ecchymosed spot on the skin of the left ankle, and a deep wound on the foot. The whole of the left hemisphere of the brain was disorganised and liquefied*, except the corpus striatum. *There were injuries to the left lung.* Mr. Clark of Farnham reports the case of a man, aged seventy-four, who survived his injuries two days ["Lancet," 1872, vol. i., p. 77, and Taylor, *loc. cit.*, p. 133]. Whilst standing under a fir-tree he was struck by lightning during a storm, and suddenly thrown on his face. When seen soon afterwards he was *moaning*, and quite *unconscious*; *his legs were paralyzed, the arms partially so.* His hat, jacket, waistcoat, trousers, and one boot, were rent and ripped open. *Blood flowed from a serrated wound on his right temple*, from several small wounds in his head and face, and from his [lacerated] mouth. The wounds were neither ecchymosed nor contused. He passed a restless night, still moaning; pulse eighty, weak, irregular, and intermittent; his breathing deep and hurried, and he was *unable to speak. The bladder was paralyzed.* After twenty-seven hours his symptoms were worse; he was very violent, and much ecchymosis appeared round the right eye. The hair of his head, eyebrows, eyelashes, whiskers, and pubes on the right side was burnt off, or singed; and his cuticle completely charred in places. Some blood oozed from the mouth and nose; his palate seemed charred and black, the mouth drawn a little to the left side, the tongue dry and brown. He passed another restless night; twitchings of the left muscles came on with facial paralysis, and he died without recovering consciousness fifty-seven hours after he had been struck. Much blood was found effused between the scalp and skull. *A fine fracture, 1¼ inch long, was found in the squamous portion of the temporal bone*, terminating at the suture. There was *another fracture at right* *angles to this*, the included portion of bone being black and charred. The temporal bone was forced out, and raised above the level of the other bones. There was *an effusion of thick blood on the dura mater corresponding to this* fracture. *The brain and its membranes* were both *lacerated.* On the orbitar plate of the frontal bone a charred spot was seen, through which the electric fluid had passed. In the "Ann. d'Hygiène," 1871, 1, 478, M. Tourdes relates the following :—"In 1869 three soldiers sat under a tree during a storm. They were struck down by lightning, and two were killed on the spot. There were loftier trees in the neighbourhood; a lightning conductor was not far off, and an iron railway bridge and a river were near. The electric fluid struck the lower tree, and passed through the bodies of the men, in place of being carried off by the surrounding conductors." As further examples of what some would term the *vagaries* of lightning,* take the following from Dr. Taylor :—"In June, 1871, a coachman whilst driving was killed, during a storm, whilst the footman, sitting by his side, escaped uninjured. The electric fluid had struck the coachman on the head, destroyed his hat, and rent his clothes. It passed through his body, tore a large hole in the cushion whereon he was sitting, and, except the shattering of the glass, did no injury to the carriage, nor to those who were inside. At about the same time three men were mowing in a field during the same storm. They put down their scythes and sought shelter; but as they were leaving the field they were all three struck to the ground by lightning. One only was killed. *It was found that he had been struck on the right side, where he wore a steel chain with a watch. This* [? the watch] *was broken to pieces.* In another accident, occurring at the same date, a man, aged seventy-four, was struck whilst standing under a fir-tree. He was taken up *insensible, and soon died. There was a jagged wound over the right eye*, and a *great part of the surface of the body* was *burnt, including the hair, whiskers, eyebrows*, and *eye-lashes. The boots were burnt off the feet, and the hat and trousers were torn to pieces.*"

It is said that in the United States in 1870, there were 202 deaths from lightning out of 500,000 deaths: of these only 54 were females, or in the proportion of 26·73 per cent. This comparative immunity of females is borne out by British cases. This, of course, depends to a large extent on the other fact, that a very large proportion of the deaths occur out of doors. Yet Bugge (Deutsche Klinik, June 20, 1874) mentions the case of a delicate girl, struck by lightning in a room. At first, he says, she only had headache, dilated pupils, dyspnœa, and palpitation; then she had systolic and diastolic bruits over the heart after twelve days. In six days more right hemiplegia, and on the thirty-third day death. There was, unfortunately, no post-mortem examination. Eulenburg records a very curious case of *hemiplegia* with subsequent recovery, from the *effects of lightning.*† The patient was a pointsman, aged forty-two; and on the night of August 4—5th, 1873, was just winding up a clock in the signal-department of the Berlin-Stettin Railway. He had only just inserted the key with his left hand (always used by him in his work) when a flash of lightning flew along the telegraph-wire into the clock, thence to the key, and thence to the left half of his body. He lost consciousness at once; and this state lasted for a full hour. On recovering this, he dragged himself into a waiting-room. Next morning medical examination showed *total loss of motor power in left arm and leg, and considerable loss of common sensation*, and of the localization of impressions. *Headache, insomnia*, vertigo, slight muscular tremors, constipation, and retention of urine were felt for a few days, and then passed off. After ten months the leg improved, but the arm remained in *statu quo*. It hung down quite limp, and all movement seemed abolished, except in the fingers and thumb. The *nutrition of both limbs was also much impaired*. Under treatment by the constant current, &c., he gradually improved, and at the end of seven months more was nearly as well as ever. Dr. Barnes [see The Deaths from Lightning at Ewell, in the "Medical Times and Gazette," June 20, 1868, p. 671] narrates a case in which a *blood-clot was found in the left cerebral hemisphere*. The man was struck by lightning whilst on horseback. There was, however, a bare possibility that the hæmorrhage was due to a fall from his horse.

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* When lightning attacks the common birch (*Betula alba*), it is said that it never runs along the stem, but confines its stroke to the top alone, beating off the boughs in every direction. [Good's "Study of Medicine," iv., p. 605.]

† "Berliner Klinische Wochenschrift," No. 17, April 26, 1875; and "London Medical Record," vol. iii., No. 125, p. 320, May 26, 1875.

If we analyse all the cases recorded, we shall find that there are various modes of death from lightning. In other words, death and other accidents from lightning occur:

(1) Like any other *shock*, producing syncope, concussion of the brain, and spinal cord, &c.

(2) By *burns;* like an intense and fierce heat, setting fire to the hair, skin, and clothing of bodies, also to haystacks, buildings, &c., and melting metallic articles.

(3) By *explosion*, like gunpowder or dynamite. [See the chapter on "Wounds;" section on "Firearms and Explosive Substances."] The lightning splits trees, and shatters large stones, rends and tears clothing, bursting even leather boots, breaking bones, and producing ragged wounds.

(4) By acting like a *drill*, or *cutting* instrument; it stabs and pierces the flesh, perforates hats, &c.

(5) By acting *chemically* on the blood, producing peculiar modifications of that fluid, and making it slow to coagulate; also, in some cases, retarding post-mortem rigidity.

(6) It acts *magnetically* upon steel knives, keys, &c., inducing powerful magnetic polarity, so that the blade of a pocket-knife may become a magnet. It may also derange and destroy the magnetism of pocket-compasses, and telegraph apparatus, stop watches and clocks, &c.

It will thus be seen that although (as in the case of death from *return shock*, when there may be no injury to the clothes, or marks on the body) it may sometimes be difficult to find proofs that death has resulted from lightning; and although in other cases the severity of the injuries might lead to the suspicion of criminal violence, yet, in a very large number of deaths from this cause, there is sufficient evidence from the surroundings, and from the appearances of the clothing, and of the dead body, to warrant us in attributing death to the action of the electric current. Now that powerful galvanic batteries are becoming common in scientific institutions and private laboratories, it is by no means unlikely that some deaths (accidental, or otherwise) may happen from the sudden discharge passing through the human body. If called to such a case, make at once a careful examination, sketch, and memorandum of the *exact position of the body*, as well as of the markings on it. Note, also, its *proximity and relation to the battery;* and the nature of the battery, with the arrangement of its wires, commutators, conductors, &c.

EXTREMES OF TEMPERATURE.

Death from great Cold or great Heat.

The human body, in health, has an average or mean temperature of 37° C., or 98·6° F., or 29·6° Réaumur, in the axilla, and nearly the same in the mouth. In the rectum [or vagina] the temperature is a trifle higher; perhaps $\frac{1}{2}$° to 1° C. =—$\frac{9}{10}$ to 1 $\frac{8}{10}$ F. The fluctuation, or daily *range* (excursus) of temperature in health, does not exceed about 1° C. (= 1·8° F.) in either direction, above or below the 37°, or about 2° C. (3·6° F.) in all. In other words, the temperature in the axilla, may *fall* to about 97° F., or *rise* to 100° F., without *collapse* on the one hand, or *fever* on the other. Even in children, whose temperature is very mobile, these limits are seldom exceeded. Most diseases, accidents, and injuries, cause the temperature to rise or fall beyond these limits. On this the use of the thermometer in medicine and surgery is founded. The scope and purport of this work do not permit of our doing more than mention these general facts, and referring the reader to such works as those of Wunderlich [a translation of whose work, "Das Verhalten der Eigenwärme in Krankheiten," Leipzig, 1870, is published by the New Sydenham Society], Seguin; ["Medical Thermometry, and Human Temperature," New York, 1871]; and H. Roger ["De la Température chez les Enfants, &c.," Paris, 1844.] From the investigations of medical and scientific travellers, it would seem that the heat-*regulating* powers of the human body suffice, in health, by the use of appropriate food, clothing, and other means, to preserve the bodily temperature within these limits or narrow ranges. Age, sex, condition in life, and the season of the year, make far less difference than would be supposed from *à priori* reasoning. As might, however, be supposed, few things are more trying to the body, even in health, than sudden or rapid changes of temperature, whether in the upward or downward direction. Men can live and thrive both in the Tropics, and in the extreme North and South; but those seasons and places in which there is a very great diversity of temperature between different hours of the same day, must be considered as unhealthy. We may mention, as a corollary of this, that the one circumstance in which the various "health resorts," recommended for consumptive patients, agree (and they agree in nothing else) is, that the daily fluctuations of temperature in such places (some of which are very warm, others very cold) are very slight. In London or Paris the night temperature often differs from that of the day by 30° or 40° F.; but such changes are very trying to invalids. Torquay, Madeira, Egypt, Australia, and the Engadine, have a far more *even* temperature. It is difficult to place any limits to the degrees of either heat or cold [short of being absolutely frozen, burnt or melted to death], which may be temporarily borne by the human body. Captain Nares and his officers and men lived for some weeks where thermometers marked 100° F. (=—55·5° C.) of frost. Chabert, the "Fire King," was in the habit of entering an oven whose temperature was from 400° to 600° F. [205° to 315° C.], whilst Chantrey's work-people were exposed to almost as intense a degree of heat for a short time, for the floor of the oven was red-hot, and a thermometer in the air stood at 350° F. [=176·6° C.]. But in the case of extreme degrees of heat, the exposure is but brief, and the "spheroidal state" assumed by water under certain conditions probably causes the perspiration to protect the skin. We know, again, that certain accidents and diseases lead to very high *internal* or bodily temperatures in some cases, and to very low ones in others. Thus 108° F. is pretty common in severe agues and in neuroses; 115° F. has been attained in scarlet fever, and 122° F. in a case of Mr. Teale's [of Scarborough], after fracture of ribs and other injuries by fall from a horse [Meeting of Clinical Society, Feb. 26th, 1875]. Very high temperatures, and sometimes very low ones, occur shortly before death. Very acute diseases, especially neuroses [such as tetanus, &c.], and fevers, including cholera amongst the latter, are known to exhibit great heat just before, during, and soon after death [see p. 16]; whilst one case of alcoholism, with exposure to a cold damp atmosphere, brought the original temperature as low as 78·8° F. [26° C.] according to Magnan.

Dr. J. J. Reincke* (police surgeon in Hamburg) records the case of a man, aged thirty-four, picked up at midnight in a state of intoxication. The temperature of the air was 30° F. At 8 a.m. the man's temperature in the rectum, was only 75° F., in two hours it had risen to 77° F., at twelve noon it had reached 82° F. Reaction then set in, and it soon became above normal. He recovered perfectly.

But these cases are exceptional. The high temperatures of fever, &c., may be, and often are, tolerated, and recovery takes place, because there are intermissions—or at least, *remissions.* Many consumptive patients live some weeks or months with temperatures greatly above normal, because at some hour of day or night, if not every day, at least every other day, their bodily heat falls either to normal, or very near it. But as a general law, we may take the following as a correct statement of fact:

When the temperature [in the rectum] of a warm-blooded animal [Mammal] is raised by any means 11° *or* 13° *F.* [=6·1° *to* 7·20° *C.*] *above its natural or normal heat, the animal dies if this increased temperature persists for any length of time.* [De la Roche and Berger,† Bernard Walther, Edwards, Chossat, &c. See also "Lecture and Experiments" by B. Ward Richardson, "Medical Times and Gazette," January 9th, 1869.] Bernard's experiments show that even 7° to 9° F. *plus* the normal heat, if continued, kills most animals. *Cadaveric rigidity sets in rapidly in such cases; it is very strongly marked, and it lasts a long time.* Dr. Richardson made some experiments in which animal substances were exposed to very high temperatures (340° F.), with little or no air, enclosed in plaster-of-paris, &c. Some very curious results were obtained, for the details of which we must refer to the page in the

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* "British and Foreign Medico-Chirurgical Review," April, 1876.

† "Expériences sur les Effets qu'une forte Chaleur produit sur l'Économie," Paris, 1805; "Journal de Physique," t. 63, 71, and 77.

"Medical Times and Gazette," quoted above. It would appear that blood and the pigment of the eye resisted great heat better than almost anything else. After long exposure to heat, far above boiling point, blood was still easily recognisable by its chemical characters. Bones, and the scaly coverings of animals, were next in power of resistance. Shells of fish and eggs, and the feathers of birds even, left well-marked traces in the plaster, &c. These facts, and the examination of calcined remains of bones, &c., recorded by Tardieu and Robin ("Affaire Lemoine," 57th and 58th Cases, *loc. cit.*, "Infanticide," see on p. 812), and several cases recorded by Dr. Taylor are encouragements to explore thoroughly the ashes and other *débris* in cases of fire, especially where there is reason to suspect intentional arson. Again, Walther's experiments show *that death is inevitable if a warm-blooded animal be kept long in cold so intense that its normal temperature is depressed about* 10° *or* 15° *C.* [= 18° *to* 27° *F.*]. Indeed, rabbits died as soon as their temperature fell 9° C. (16·2° F.). Artificial respiration restored some of those which had not been quite so much cooled, and enabled them to regain their original animal heat. But unless artificial respiration were used, it was found that long exposure to cold prevented their getting warm again, even in a warm atmosphere. In men and strong animals, reaction is apt to set in after intense cold, so that even febrile temperatures are reached. Yet experience shows a wonderful *law of tolerance* as regards not only extremes of temperature as borne by different nations, but variations of temperature, as borne by aëronauts and travellers, Arctic explorers, &c.

You might, in order to settle some questions of *survivorship*, be asked *whether young, middle-aged, or old people, and which sex, bear extremes of heat and cold best.* Your answer must be, so far as experience and experiments allow us to formulate an answer, as follows :—

1. *Infants and very young children, and very old people of both sexes, have limited powers of heat-production. They, therefore, bear extreme cold badly. Older children and young adults bear cold better than either their seniors or juniors, and young males better than females of the same age.** Some have said that females being fatter, bear cold better. This is, however, not true before puberty, and as a general rule, males will bear all hardships better, being more accustomed to exposure from their out-door avocations.

2. The young are said to bear extreme heat better than middle-aged or older people. (Beck states this on the authority of Burckhardt, as regards the Nubian deserts.) But this point requires further confirmation. Many of the victims of sunstroke are young people, and one of the earliest recorded cases (2 Kings iv. 18 and 19) was in a child.

In the absence of definite experiments, or cases bearing on this point, we cannot do better than fall back on such general rules as those of the old *Roman law*, and of the *Code Napoléon.* [See pp. 612—614.]

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* Heat-production in the human body is a complex problem. Much of it is derived from tissue changes, and the decomposition of nutritive substances. If we admit that very much of it is produced by muscular movements, and especially those of the ventricles of the heart, the left ventricle especially, this view will explain the statement in the text. The work of the left ventricle is stated by Buchanan to be equal to 42·3 foot-tons in twenty-four hours.

The Effects of Extreme Cold.—Frost-bite, Death from Exposure, &c.

According to the reports of the Registrar General, some 141 deaths in 1870, and 114 in 1874 occurred from exposure to cold. Few winters pass without such cases. The majority are, unfortunately, complicated by previous starvation, or such privations as have destroyed the power of resistance to cold possessed by healthy bodies. The benumbing effects of cold are not only familiar to most, from the experience of severe winters, but have been further exemplified in the experience of whalers, and Arctic explorers, and in the disastrous retreat from Moscow of the French army in 1812. The painful feelings first produced, and the purple lividity of the skin, which is not seldom vesicated, are succeeded by numbness, anæsthesia, and pallor of the skin. Stiffness of the limbs, chiefly due to the muscles, succeeds; then torpor, and a condition of coma, from which the sufferer can be roused only with difficulty. Lastly, complete suspension of respiration, and of the heart's action ensue, and the victim perishes. In the polar regions it is considered fatal to go to sleep whilst marching. C. Bernard found that the blood absorbed less oxygen at a low temperature. [Leçons, 1859, p. 114.] Delirium, vertigo, and even symptoms of intoxication have been noticed by the Arctic explorers. Dr. Hartshorne ("American Journal of Medical Science," Oct. 1861, p. 432), quoted by Dr. Taylor, gives a case of death on the third day after exposure to cold, with headache, drowsiness, vomiting, high temperature, hard and quick pulse and delirium. In fact, the symptoms were not unlike those of sunstroke. It has before been noticed that extreme heat and extreme cold give rise to very similar symptoms.

Great fatigue, exhaustion from want of food, mental depression, habits of intoxication, or the previous ingestion of a large quantity of alcohol, previous illness, great age, early infancy, in fact, any thing which tends to lower the physical powers, will predispose to the severe or fatal effects of cold. *Damp cold* (such as wet clothing, a cold, damp atmosphere, or partial immersion in water during cold weather, as in wrecks) *is far more depressing and dangerous than dry cold.* [See Wunderlich on "Temperature," New Sydenham Society's Translation, pp. 128, 322, &c. &c.; Horn's "Vierteljahrschrift," 1868, 2, 44; "Ann. d'Hygiène," 1838, 1, 436; Casper's "Vierteljahrschrift," 1865, 2, 140; "Medical Times and Gazette," July 21, 1860, p. 61; "Annales d'Hygiène," 1831, p. 207; Beaupré on "Cold," Larry's "Surgical Memoirs," translated by Dr. Clendenning, p. 78; Dr. Kellie, "Edinburgh Medical and Surgical Journal," vol. i., p. 302; "Edinburgh Medico-Chirurg. Trans.," vol. i., p. 84; Dunlop's "MS. Lectures on Medical Jurisprudence," quoted by Beck, *loc. cit.*, p. 517.] In a footnote to page 519, Beck collects a number of cases of sudden death from drinking cold water when heated. We believe these cases do not strictly belong to the effects of cold. They are far more akin to *heat-apoplexy*, of which we shall treat presently.

Many people when very hot drink freely of the coldest drinks, and take ices with almost perfect impunity [*see* Beck, *loc. cit.*, p. 518; also "Penny Magazine," 1834, p. 348]. And although when the use of ices first became common in America and England, there were many dreadful prognostications of the evil effects which would result; we believe that these predictions have for the most part been falsified. How then do we explain the cases, which undoubtedly do occur from time to time of sudden death after the ingestion of a large quantity of cold water when the body is heated? Our answer must be :—

(1.) That in most of them there has been extreme fatigue, and the body has been subjected to great heat. Death has therefore ensued from syncope, exhaustion, or solar apoplexy in many of the cases.

(2.) Others may perhaps be explained by the ingestion of a large quantity of this fluid causing the red blood corpuscles to swell inordinately, and thus produce blocks or embolisms and congestion, in the capillaries of the lungs and other organs.

(3.) A few may possibly be due to the shock which the fall of temperature produced by the cold liquid has caused to the heart.

Amongst the minor effects of cold, chilblains, and sores on the extremities which are slow to heal, may be mentioned. In what is called *frostbite*, the part which at first was livid and cold, and numb, becomes almost bloodless, of a livid tallowy paleness, perfectly insensible, and much reduced in bulk. The nose, ears, or extremities are the parts most likely to suffer. In the case of rabbits and poultry, John Hunter and others showed that the ears of the rabbit and the combs of cocks may be so frozen as to be quite hard and brittle, and yet recover vitality with proper care. And some of the lower animals may be frozen entirely and yet recover.* Wonderful stories of the recovery of frozen men have been told by authors; yet if the whole body be frozen, we have no authentic case of recovery.

If the frozen parts be warmed too suddenly, *gangrene* is very apt to set in. Baron Larrey ("Méd. de Chirurg. Milit." tom. iii., p. 60) says that during the French campaign in Poland in 1807, for a few days before and after the battle of Eylau [the 7th and 8th of February], there was most intense cold, ranging from 10° to 13° below zero of Réaumur, [=20° to 25° below the freezing point of Fahrenheit]. Snow fell during most of the battle. But though the troops were day and night exposed to this most inclement weather, and the soldiers of the Imperial Guard in particular were nearly motionless for twenty-four hours, there were no complaints of its effects. But on the night of the 9th of February *a sudden thaw commenced, and immediately a great number of soldiers presented themselves at the "ambulances,"* complaining of severe numbness, pain and pricking of the feet. Some had merely symptoms like chilblain, others frostbite, but many had gangrene, and the toes had already become dry and black. In this manner the toes, and in some the entire foot perished. Mr. Solly mentions a similar case in the arm of a tanner [South's "Chelius," vol. i., p. 128; Driutt's "Surgery," p. 156, chap. v.; Miller's "Principles of Surgery," p. 275.

Cold, when very severe, invariably increases the general rate of mortality. Dr. Carpenter in his "Principles of Human Physiology," 7th ed., p. 497, quotes an interesting table from Quetelet's "Essai de Physique Sociale," tom. i., p. 197, in which this fact is strikingly shown by the mortality at Brussels for various ages, in the different months of the year. This is particularly the case in early infancy, and in advanced life. MM. Villerme and Milne-Edwards have shown the same fact as regards the mortality of children in French foundling hospitals; and the weekly returns of the Registrar-General show that, instead of a weekly average of 1,100 or 1,200, the deaths rise to 1,600 or 1,800, or more, when the mean temperature of the week remains six or eight degrees below the freezing point. This fall of temperature affects even the well-to-do classes, as is shown by the "Deaths" column in the "Times," in the winter months.

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* See some experiments on toads, in the "London and Edinburgh Journal of Medical Science," Feb. 1843.

Treatment of Frost-bite, and of person exposed to extreme Cold.

We must refer to medical works for details, but the principle is, to restore gradually the warmth of the part, and to avoid very sudden changes of temperature. To do this, the part should be rubbed well with snow (or iced water), after a time cold water may be substituted, then dry friction. No fire should be in the room, if a small one; or, in a large room, the person should be at a distance from the fire: the limb should afterwards be wrapped in cotton wool, or some similar non-conductor. *Vesications* should be treated with some stimulating ointment, as resin cerate. Ulcers and sloughs may require poulticing. If the whole body be much chilled, the patient should be put to bed in a room of moderate temperature, ammonia and weak wine and water administered. Dry friction used, or stimulating embrocations. *Gangrene* should be treated much as *senile* or *dry gangrene* in general, for which we must refer you to works on surgery.

Cold as a means of Murder.

This is happily rare. One such case is recorded in the "Annales d'Hygiène," vol. vi. (1831) p. 207 (*see also* the "Medical Times and Gazette," July 21st, 1860, p. 61, and Beck, and Taylor, *ad rem.*]. The case is related by Dr. Ozanam of Lyons. A man and his wife were tried at Lyons for the manslaughter of his daughter and her stepchild, a girl aged eleven years, whom the brutal woman, after a long course of starvation and ill-treatment, compelled to get out of bed on a cold morning in December, and forced to enter a barrel filled with cold water. Although extricated by a servant after some time, she was again replaced by the brutal mother, and in it she died. On the trial for this crime the woman was condemned to imprisonment for life. There was here neither submersion nor suffocation, but the child doubtless died from the effects of cold added to the previous ill-usage.* In *Regina* v. *Lovell* (Glo'ster Lent Assizes, 1853), a woman was convicted of the manslaughter of a child aged only four years. The child, already diseased, was put under the spout of a pump in cold January weather, and the water pumped over her. Although the medical witness did not think this accelerated the death, the jury (as we think rightly) did, and found the prisoner guilty. The late Justice Talfourd remarked that the verdict was based on common sense and reason, although against the opinion of the medical witness!

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* Dr. Ozanam uses the word *assideration* in reference to cold being the cause of death. It is equivalent to our word "concomitant."

Post-mortem appearances in Death by Cold.

These are, unfortunately, not very distinctive. *Rigor-mortis* generally sets in slowly, but lasts for a long time. You must not mistake the mere stiffness of cold for this. *The skin is generally pale. All the viscera of the chest and abdomen and the brain are usually found congested.* The *venous system is specially full.* In two cases examined by Dr Kellie of Leith,* the persons had died on the night of the 3rd November, 1821. The external appearances were not remarkable. The brain and its membranes were congested. In the ventricles and at the base of the brain, three or four ounces of serum were found. The stomach was of a pale colour, and the small intestines were reddened. The liver also was congested. A case of recovery from the effects of cold is given by Dr. Kellie in the "Edinburgh Medical and Surgical Journal," vol. i., p. 302. He quotes a *post-mortem* by Quelmaly in the sixth vol. of Haller's "Disputationes." Here the vessels of the brain were turgid with blood, and serous lymph was effused into the ventricles of the brain. In Casper's "Vierteljahrschrift," 1865, 2, 140, there is a case occurring to Dr. Hilty of Werdenberg, in which a man aged fifty-seven died from exposure to cold, in a state of intoxication. In his case the congestion of the internal viscera was still more marked, and the bladder was distended with urine.

When asked, therefore, if death has resulted from cold in a given case, your answer must be founded on common sense, rather than on special phenomena. You must consider the absence of other signs and causes of death, especially the absence of signs of violence, the season of the year, the place and circumstances where and in which the body was found, the external temperature, &c. The surface of the body may, in some cases, show patches of redness [frost-erythema], as in the case quoted above. It is much to be wished that more accurate accounts of *post-mortem* examinations in such cases were on record.

A few more references will be found in the articles on Cold, in "Copeland's Dictionary of Practical Medicine." Dr. Copeland calls special attention to the injurious effects of a cold bath when the body is much fatigued by muscular exertions, sexual excesses, and the like. For want of knowing or attending to this, Alexander the Great nearly lost his life.

Our space does not permit our giving directions how to guard against cold. The use of non-conductors (furs, flannels, &c.), as clothing, and of a tolerably liberal diet and exercise, and artificial warmth, are the chief means at our command. We must not, however, omit to remind you of the *uses of cold in surgery,* with which the name of Esmarch is especially connected. Those not conversant with the medical art are apt to wonder why heat and cold should both be used for the treatment of inflammations. It is not possible to give a brief and categorical answer. Both have been proved to be useful, and the key to this apparent paradox may perhaps be found in the fact that the effects of extreme heat and extreme cold in the human body, and on other mammals are very similar in many respects. As an example take the production of blisters or vesications in the limbs.

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* "Edinburgh Medico-Chirurgical Transactions," vol. i., p. 84.

The Effects of Extreme Heat.

We have already noted (p. 879) that when the temperature of a warm-blooded animal is raised much above the normal, it soon dies. This rise may be caused partly by raising the temperature of the surrounding media, and partly by preventing the giving off of heat from the skin. Sugar-houses, engine-rooms, hot-houses used for growing plants, and factories of various kinds, as well as Turkish baths, are often heated to an intense degree, and the air is so saturated with moisture that there is but little evaporation from the skin. In the engine-rooms of steamers, Dr. Taylor states that the temperature is often 145° to 150° Fahrenheit in the tropics. In Turkish baths from 180° to 200° Fahrenheit has sometimes been attained. Deaths in both these situations have not unfrequently happened. One or two of the children of the late Mr. Urquhart died in this way. The first effects are to accelerate enormously the action of the heart, to cause a feeling of giddiness and suffocation, and unless sudden death results, to end in coma, feverishness, and congestion of the lungs, &c. We have here sometimes sudden death, as in the cases given above, and in another recorded by Dr. Taylor (*loc. cit.*, p. 138). He says: "In July, 1861, an inquest was held in London on the body of a stoker of an Aberdeen steamship. He had been by trade a grocer, and was not accustomed to excessive heat. While occupied before the engine furnace, he was observed to fall suddenly on the floor in a state of insensibility; when carried on deck it was found that he was dead. All that was discovered in a *post-mortem* was an effusion of serum into the ventricles of the brain; death had been caused by sudden apoplexy." It is probable, as Dr. Taylor says, that excessive heat generally acts by producing apoplexy—*Heat apoplexy.* When caused by the heat of the sun, or extreme hot weather, this is called *coup de soleil.* During 1870, 112 deaths from sun-stroke occurred in England, and in 1874, some ninety deaths were registered from this cause. In New York of late years the hot summers have been marked by an almost appalling number of deaths from this cause. The prevalent practice of excessive ingestion of spirituous liquors in that city has probably had its share in the mortality. Sun-stroke also attacks troops on the march. Except when absolutely unavoidable, as on the eve of, or in a battle, it ought to be an axiom with commanders, that troops ought not to march during the hottest hours of the day. The weight of the soldier's knapsack, and tight articles of dress around the neck, contribute to the fatal result in this case. The symptoms in life are weakness, vertigo, headache, confusion or (temporary) loss of sight, flushed face, great difficulty in breathing, stupor, and coma in bad cases. The skin is hot, sometimes *petechiæ*, or spots like those of typhus, appear on it, and the temperature is very high (104° to 110° F. or more). In mild cases there may be only a momentary loss of consciousness, followed by drowsiness. In bad ones there may be profound coma for some days. The pupils are generally dilated in the earlier stages, and *contracted to a fine point* in the later ones. The mortality is not far from 50 per cent., and those cases which recover are liable to catalepsy, epilepsy, insanity, paralysis, and other neuroses. [*See* Levick's "Remarks on Sun-stroke," in the "American Journal of the Medical Science," vol. xxxvii., January, 1859, p. 44. A good account of this disease, which is also called Insolation, will be found in

Dr. Aitken's "Science and Practice of Medicine," vol. ii., p. 380. *See also* "Annales d'Hygiène," 1867, 1, 423; and the "Lancet" for 1872, vol. i., p. 464, vol. ii., p. 128, and *ibid.* for 1870, vol. i., p. 423.]

Treatment of Heat-Apoplexy.

The coverings round the neck, and any tight articles of dress, should be immediately loosened or removed. The person should be carried to a cool place and laid on the ground, or on a bed or couch, in a recumbent position. Then all clothing but one thin garment (such as a shirt) and all heavy bed-clothes should be removed, a single sheet being sufficient. Ice should be applied to the head. In bad cases, the body also should be rubbed with ice or iced water. When he can swallow, stimulants and ammonia may be administered along with light nourishment [milk or beef-tea] and a full dose of quinine. Salines and mild aperients might be given afterwards. The general opinion is against bleeding, but it is probably useful in some cases. Stimulants should be given in very small quantities at a time. Quietness is essential. Counter-irritants may be useful in some cases. The after-treatment must depend on the symptoms which develop themselves.

Post-Mortem Appearances.

Levick has shown (*op. cit., supra*) that these are almost identical with those of typhus fever, petechial or spotted typhus. He gives the appearances of each, side by side, in a table. *None of these are absolutely distinctive.* Dr. Aitken shows that, as in hanging and drowning, death may occur in sun-stroke also in two ways, by *syncope* and by *asphyxia.* Some of the sudden deaths would probably be syncope. [See Modes of Death, p. 633.] In the majority, however, particularly when life has been prolonged some hours, we should find as follows:—*Rigor-mortis* comes on quickly; putrefaction sets in very rapidly; livid spots and *petechiæ* are often found on the body; the brain and its membranes are congested with numerous *puncta cruenta,* and perhaps there is serum in the ventricles. *The lungs are specially dark and injected with blood, particularly the central and posterior parts, and at the bases;* there are often large and numerous pulmonary apoplexies or extravasations of blood; the heart is filled with liquid blood, especially the right heart; and the veins are also greatly congested. The blood coagulates badly, and is very dark in colour. In some cases neither heart nor brain may present any special symptoms. The liver and spleen may be large and dark.

DEATH BY FIRE—BURNS AND SCALDS, SPONTANEOUS COMBUSTION.

From the Reports of the Registrar-General it would appear that there is an annual loss of life from fire, including burns and scalds, of nearly 3,000 lives. About 300 of these are in London alone, and about three-eighths are children under five years of age. Many of the fires occurring in dwelling-houses, as they occur in suspicious numbers about the quarter days when the rent is due, or after the discharge of unfaithful servants, or on the eve of a bankruptcy, must be attributed to wilful and criminal wickedness; a great many are, however, due to accidental causes, such as fire spreading from a chimney to the walls of a dwelling-house [there are many chimneys into which the rafters or beams actually protrude]; the foolish practice of throwing lighted pieces of paper, and smouldering matches on the floor; sparks from the fire, and hot coals falling out where there is no fire-guard, children playing with fire, and other causes of similar kind, too numerous to mention. Cats and other domestic animals are supposed to cause some fires in the night by their habit of creeping under the grate. If startled by a hot coal falling on their back they rush out, and the coal may fall on a wooden floor, or on a heap of shavings. Like the lodging-house cat, the domestic variety, *felis domestica*, is thus made a scapegoat of. Smokers are, however, far too careless as to fusees, matches, and cigar-lights. The carelessness of servants is proverbial.

Dr. Guy justly remarks that in fires occurring in dwelling-houses, the causes of death are manifold, as for example :—

A. Some of the victims are simply *suffocated* by the smoke, or rather the gases and vapours arising from the burning materials. Of this our hospital experience affords us examples, as it does of resuscitation from apparent death by this means. For the symptoms, post-mortem appearances, and treatment, see the chapter on Poisonous Gases (pp. 550-70), and on death by apnœa (pages 918—960). It is well to remember that a current of cold air is often met on the floor of a room.

B. A few may die of *shock or fright* [see On Modes of Dying, p. 633]. Very old persons, young children, and nervous subjects are most likely to die in this way.

C. Blows from falling bricks, stones, or other materials of the burning structure, may cause instant death, or death at a later period. The late Mr. Braidwood met his death in this manner—as many firemen have done.

> [We must refer you to our chapter on Wounds for information as to the post-mortem and other appearances.]

D. In endeavouring to escape, or to save life or property, people may fall from windows or roofs, or from the top of a wall, or off a ladder, and thus meet with dislocations and fractures of their limbs, fracture or other injuries of the skull, injuries to the spine, concussion or compression of the brain, and other severe or fatal injuries [for these see next chapter].

E. When they are severely burned or scalded, or have met with other severe injuries, they may die of *collapse* or shock, never rallying fram the first severe injury to the nervous system. This form of death is really very similar to the death from fright, mentioned under head B. Very extensive burns and scalds, those on the trunk, and those attended with intense pain at first, are most likely to kill thus. We shall recur to this shortly.

F. Many of the deaths are due to the inflammation and other sequelæ which ensue after burns and scalds, or any of the other accidents met with in fires.

Nearly all cases of burns are *accidental*.

Very rarely *suicides* choose this mode of death; and as we have seen under strangulation [case of the Countess of Goerlitz, and another quoted by Dr. Taylor from Dr. Schüppel of Tübingen (p. 948)], *murder* is sometimes *attempted to be concealed by fire*. There are also a few cases in which *murder by fire alone has been attempted or perpetrated*. The proofs in these cases must, however, in general (unless in cases of previous injuries, strangulation, &c.) rest on other than medical evidence.

The questions likely to be submitted to you are the following :—

1. Are the marks on the body those of burns or scalds ?
2. Were they inflicted before or after death ?
3. If before death, were they sufficiently severe to be fatal
4. Are there marks of any other disease or injury which might account for death ?

The last question must be answered after reference to our chapter on Wounds, &c.

The other questions may be conveniently taken here. In order to answer the first, we must enter on some general questions relating to these injuries :—

As in the case of any accidental death, if the sufferer die *within a year and a day from the reception of the injury, an inquest is absolutely essential.* In all cases in which there is a clear *nexus causalis* between the injury and the death, such an inquiry is desirable. Medical men are wrong in endeavouring (as they sometimes do) to hinder an inquest. No matter what the rank of the sufferer may be, these enquiries are useful to others. No doubt an inquest is often a disagreeable tax on the time of a professional man, but so is serving on a jury (from which you are exempt) to a tradesman. But both are public duties.

We must first define our terms :—*A burn* is said by Mayne to be "a lesion of some part of the body, of greater or less extent, caused by the application of heat ;" but this definition is defective, for it would include scalds, and *coup de soleil.* That given by Dr. Taylor is far better, viz., "a *burn* is an injury produced by the application of a heated substance to the surface of the body." The death of King Edward II., and of others from melted lead to be mentioned presently, show that this definition also errs in using the words, "to the *surface.*" A *scald* is said to be "the result of the application of a liquid at or near its boiling point," either within the body (as by drinking it), or outside it. Dr. Taylor justly remarks that there seems no real distinction between a burn and a scald, as to the effects produced on the body, *except in the case of boiling water,* which, although fatal, never causes such great destruction of parts, as may result from fire, or from melted metals. Boiling mercury, melted lead, and the like, would cause injuries which might be described as either burns or scalds at pleasure. A sodden state of the skin is produced by severe water-scalds, whilst slighter degrees can with difficulty, if at all, be distinguished from burns.

The injuries from corrosive liquids, such as oil of vitriol (impure sulphuric acid), aqua fortis (impure nitric acid), spirits of salts (impure hydrochloric acid), aqua regia (or nitro-hydrochloric acid), caustic potash or soda leys (or lees), carbolic acid, or other corrosive liquids (such as Burnet's fluid, or acid chloride of zinc), caustic lime, &c., are popularly termed *burns,* and are so designated in the statutes. This crime was at one time very prevalent. By the 24 & 25 Vic. c. 100, s. 29, this offence is specially mentioned, and punishment provided. It is said that formerly a prisoner escaped the charge of felony, because it could not be proved in law that sulphuric acid would produce a wound ! See Taylor, *loc. cit.,* p. 697—8. We fancy few medical men would deny its wounding power. However, this statute does not define a wound, but mentions the nature of the fluid thrown as "any corrosive fluid, or any destructive substance:"—which would include dynamite, nitro-glycerine, &c. [For the special effects of corrosive liquors, we must refer you to pages 239—279 The Mineral Acids, &c., and to pages 69, 91—117, and pages 127, 231, &c.] Dr. Taylor mentions a case in January 1833, of a man (?) pouring a quantity of strong nitric acid into his wife's ear while asleep. She had a variety of symptoms, including right hemiplegia and convulsions, and died after six weeks—the ear and brain both being extensively injured, and the petrous bone carious. [" Medical Times and Gazette," vol. xvii., p. 89]. In a case at Aberdeen a woman poured oil of vitriol down her husband's throat, whilst asleep with his mouth open. In a recent case a strong solution of corrosive sublimate was used in a like way. Both these cases were treated as cases of *poisoning.* Those in which an eye, &c., has been lost, might also be treated as cases of *maiming.* [See next chapter.] In general the colour of the skin will show the kind of corrosive used—yellow from nitric acid, dark-brown from oil of vitriol, white or pale yellow from hydrochloric acid, &c.;—but for special symptoms refer to the substances, to which reference has been made above. In order to burn, some substances must be heated nearly to redness, or beyond it, or they must be in a melted or boiling condition,* but metals will produce redness and vesication and coagulation of blood and other injuries when heated to 212° F. or 100° C. The *actual cautery* is said to be more efficacious in arresting hæmorrhage when at a

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* The melting and boiling points of different metals, and other substances, differ greatly, as is shown by the following table from Fownes' Chemistry. [The degrees are Centigrade] :—

Substance.	Melting Point.	Substance.	Boiling Point.
Mercury . . .	– 39°	Aldehyde . . .	20·8°
Phosphorus . . .	+ 44°	Ether	34·9°
Lead	332°	Bisulphide of Carbon .	46·1°
Sulphur . . .	115°	Alcohol	78·4°
Iodine . . .	107°	Water . . .	100°
Bismuth . . .	270°	Linseed Oil . . .	337·7°
Cadmium . . .	320°	Nitric Acid (strong) .	120°
Tin	235°	Oil of Turpentine . .	157°
Silver	1000°	Sulphuric Acid . .	326·6°
Zinc	433°	Mercury . . .	350°
Calcium Chloride .	28·5°		
Copper	1090°		
Antimony . . .	425°		
Grey Cast-Iron . .	1200°		
Steel	1300 to 1400°		
Platinum . . .	2000°		

Pouillet determined the following temperatures by means of an air thermometer. They correspond to the stages of incandescence of a metal bar :—

Incipient red-heat	525° C.	= 977° F.
Dull red	700° C.	= 1292° F.
Cherry red	900° C.	= 1652° F.
Dark orange	1100°	= 2012° F.
White heat	1300°	= 2372° F.
Dazzling white heat	1500°	= 2732° F.

See article on Pyrometer in the " Popular Encyclopædia."

black heat, than when red or white. The skin is generally much destroyed in burns from flame (as of a gas, lamp, or candle,) whilst in gunpowder explosions accompanied with burns, many small black or bluish specks, or particles of unconsumed carbon (charcoal) are found embedded in and under the skin. Burns from *phosphorus* are always specially deep and severe from the intense heat accompanying its combustion.

The amount of injury inflicted by burns has been classed by Dupuytren as follows, in six degrees :—

1*st. Degree. The skin is only scorched, or slightly reddened, with efflorescence of the cuticle, but no permanent injury.*

2*nd Degree.* There is not only *general redness,* but there is a *formation of vesicles,* either at once, or in a few hours. Some of these vesicles or blisters may be very large, and tense with serum. [Note that iodine, cantharides, scalding liquids, melted sealing-wax, tallow, &c., metals heated to 212° F. or 100° C., and strong acids, &c., will also produce very similar vesication.] Both of these degrees are painful.

3*rd Degree.* The *cutis or skin is destroyed ; yellowish grey or brownish eschars form, and involve the whole thickness of the skin* ; the surrounding integument is more or less reddened and vesicated, and the part is extremely painful. The eschars from severe scalds will be soft and pulpy, and of an ashy-grey (sodden) character.

4*th Degree. In this the whole thickness of the skin, and part of the subcutaneous cellular tissue are destroyed ; dry, yellowish black, insensible eschars are formed, with considerable inflammation around them, leaving on their separation deep and luxuriantly granulating ulcerated surfaces.*

5*th Degree.* In this the eschars extend more deeply, and the *muscles, fasciæ and soft structures are implicated.*

6*th Degree. In this the whole thickness of the limbs is completely destroyed and charred—thus bones and all are involved.*

It seldom happens that a burn occurs in which two or three of these degrees are not mixed together. Hence Mr. Luke, Mr. Carling, and other surgeons have suggested a simple classification something like this :—

1st kind. Burns or scalds only involving the skin or subcutaneous connective tissue, more or less severely.

2nd kind. Burns, etc., which involve the muscles and tendons, with their nerves and blood-vessels.

3rd kind. Burns which involve the bones also, and (on the trunk) internal viscera. In fact the most severe kind of all.

4th kind. Mixed burns, and scalds—or those in which these various degrees are more or less mixed. As a child in drinking boiling-water (a pretty common accident in large towns), may scald its throat severely, and some part of its body (protected by dress) only slightly.

Dupuytren's first degree is produced by the momentary contact of a hot body, or by water, &c., some degrees below boiling point, and leaves no mark after a few hours. The second degree implies a longer contact, or liquids at the boiling point. Although there may be some suppuration of the vesicles, it seldom leaves permanent marks, except in persons of a bad constitution, or weakened by previous disease. The third degree invariably marks, by a shining white cicatrix without contraction of the neighbouring parts. In time this may wear out. Occasionally the cicatrix itself contracts considerably, and assumes a *cheloid* condition. The authors can positively state from their own observation that it is not possible a few weeks, months, or years, after the accident, to distinguish the marks left by some burns from those of scalds.

In the fourth and fifth degrees, there are not only cicatrices, but generally considerable deformity, from the contraction of the skin and of the deeper tissues—thus the head is often tied down to one side, unless great and unusual care be taken whilst healing. Even then it is not always possible to prevent the deformity. The arm or leg also may be contracted into a bent and almost useless position, the fingers being tied down or united together by webs of skin. Most works on surgery now contain methods of preventing or curing, as far as possible, these ugly and inconvenient sequelæ of burns and scalds. Very often limbs have to be amputated, in whole or in part, on account of the destruction of skin being too great to allow of repair, or even of plastic operations. The authors have seen very aged patients bear these amputations exceedingly well after burns. Here the question of amputation being primary or secondary might, and probably would arise. [See Malapraxis, p. 722.]

It has been found by experience, that *the danger of a burn or scald depends far less upon its severity* (or the degree in which the tissues are implicated as to depth) *than upon the amount of surface of the body involved.* In other words, the *danger of these accidents is, other things being equal, in proportion to the number of square inches of surface burnt or scalded.* It is true that injuries to the limbs are usually less fatal than those to the trunk. The explanation may probably be found partly in the greater implication of sensory nerves in extensive burns, and partly in the fact that so much of the skin is no longer able to do its work of excretion, and heat-regulation, for it is known that if we simply varnish, or paint, or coat with some impermeable material like gutta-percha or india-rubber, any considerable portion of skin, the animal becomes greatly inconvenienced—and if some three-fourths or more of the body be thus treated, the animal usually dies. This "law of square inches," as it may be called, is not only verified by the experience of all who have witnessed many cases of burns, but is strikingly shown by a series of cases with measurements, recently published by Inspector General, Dr. Wm. Smart of Haslar Hospital, in his remarks on burns by gunpowder, and scalds by steam, founded on his experience in the China war, and in the recent explosion on board H.M.S. *Thunderer*, treated at Haslar [" British Medical Journal," Sep. 23, 1876, p. 389]. The majority of the latter had from 200 to 500 square inches of scalded surface. One man, however, who had some 766 square inches [or nearly one-third of his superficies, calculated at 2,300 to 2,400 square inches] recovered. His scald was, however, only of the first degree. A scientific observer, who had been witness to the consequences of two great magazine explosions, remarked that if as much as 80 square inches of skin were damaged, there was always a degree of secondary fever present involving danger to life. Dr. Smart considers that 350 square inches thus injured places life in the greatest jeopardy—gunpowder being worse than steam. [The other effects of explosive substances, gunpowder, dynamite, picrate of potash, and the like, will be specially mentioned under Gunshot Wounds, &c., in the next chapter on Wounds].

The general effects of burns and scalds as distinguished from the purely local effects just mentioned, are sometimes called *constitutional* effects. The first effects are great *collapse* or severe shock to the nervous system. The surface of the body is pale, the extremities cold, the pulse quick and feeble; there are repeated and severe rigors or shiverings, and the patient often complains bitterly of being cold, though all the while the thermometer may mark a rising and febrile temperature. In some cases, however, the temperature is really sub-normal, as in collapse proper. In fatal cases these symptoms are soon succeeded by laborious breathing, coma, and perhaps convulsions, particularly in young children, and death; in others dissolution is preceded by a period of imperfect reaction, with delirium and sharp jerking pulse. Mr. Erichsen states, with great correctness, that the first period of *depression* and *congestion* occupies, as a rule, some forty-eight hours. Before *reaction* sets in there is usually an interval of quiet, during which the child, or older sufferer, may die comatose from congestion of the brain and its membranes, and from effusion into the ventricles of the brain. The mucous membranes of the stomach and intestines are found greatly congested, even at this early period. Death sometimes occurs from a sort of passive œdema or dropsy of the lungs; and more rarely, the serous cavities [pleura, peritoneum, &c.,] become the seat of copious and fatal effusion. *From the second day to the second week* we get the period of *reaction and inflammation.* We have *irritative fever* attended with thoracic and abdominal complications. We get *pneumonia* (perhaps *pleurisy*) or *bronchitis*, or compounds of all three; and in some cases *enteritis* and *peritonitis.* The authors, from a personal examination of many fatal cases of burns, can confirm Mr. Curling's statement that *perforating ulcers of the duodenum* are pretty common, particularly in children and young people, in whom Brunner's glands are very active.* Mr. Murray Humphrey has observed that the lower part of the œsophagus is sometimes ulcerated, and the authors have noted that Peyer's patches, and in fact, the solitary glands generally, are often greatly inflamed, and sometimes ulcerated, in such injuries to the skin as severe burns, scalds, large blisters from Spanish fly, and the burn inflicted by strong carbolic acid. Intussusception of the small intestines is also very commonly noted after death from burns, but is probably only a phenomenon attending the death. The ulcers described may set up peritonitis, or fatal hæmorrhage, by perforating the peritoneum, or a large artery. In this way blood may be vomited or passed by stool. *The first week is the most fatal period.* Thus of fifty fatal cases of burns noted by Mr. Erichsen, there died—

In the first four days	27	cases.
,, eight ,,	6	others.
,, second week	8	,,
,, third ,,	2	,,
,, fourth ,,	2	,,
,, fifth ,,	4	,,
,, sixth ,,	1	,,
	50	

The *stupor* or *coma* produced by burns and scalds, may be, and has been, mistaken for *opium poisoning.* Mr. Abernethy once gave evidence in a case where a surgeon was charged with the manslaughter of a child who had been severely scalded, because the child died comatose, and this was ascribed to eight drops of laudanum given at once, and ten drops two hours after. The surgeon was acquitted, as Mr. Abernethy deposed not only that the practice was usual, but that the dose was a proper one. Dr. Drewitt states that he gave a child of three years old ten minims of *Battley's Solution*, in divided doses every night for a fortnight, besides administering chloroform every day when the scald (a severe one) was dressed. The authors cannot concur in Dr. Taylor's recommendation to withhold opium from burnt children. *It must not be forgotten that extreme pain may be, and often is, fatal.* The late Sir Robert Peel in all probability died of the pain from his fractured ribs, rather than from any other result of the accident. *Tetanus* may supervene on *burns and scalds.* We thus see that death may be due (1), to syncope or suffocation at the time of the fire; (2), to collapse or shock very soon after; (3), to coma, convulsions, tetanus, or other symptoms referable to the brain and nervous system; (4), to bronchitis, pneumonia, or œdema of the lungs, and other thoracic causes; (5), to enteritis or peritonitis or hæmorrhage, due to abdominal lesions; (6), to exhaustion from long-continued and profuse suppuration; (7), to gangrene, erysipelas, pyæmia, and other hospital diseases; and (8), sometimes to other causes.

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* "Medical Chirurgical Transactions," vol. xxv.; Humphrey, "Association Journal," Oct. 19, 1855.

Post-mortem Appearances.

No matter how much the remains are charred, it will generally be possible, unless only ashes are left, to distinguish some particulars of age, sex, or other matters which may aid in establishing personal identity. Casper and Dr. Grünbaum [*see loc. cit.*, A. Horn's "Vierteljahrscrift," Oct., 1864], have been able to determine the sex in remains considerably charred [*see* references under Personal Identity, &c., p. 639, and Tardieu's cases of Infanticide, p. 812]. Bones often retain their form when burnt more than would be supposed from *à priori* reasoning. Even ashes, supposed to be human, should first be examined for *foreign bodies* of metal, &c., such as rings, studs, false teeth, or the gold mounts of such [as in the case of Dr. Parkman], and next by chemical analysis (1) as to their composition, and (2) as to the presence of arsenic and other poisons. It has been stated that arsenic acid $As_2 O_5$ or trihydrogen arsenate $H_3 As O_4$ will replace phosphoric acid in the bones, but we are not aware that this has ever been proved in human beings. *Occasionally no peculiar appearances at all may be found in the interior of bodies dying from burns.* If death have resulted from *suffocation*, no marks may be found outside the body. But usually we shall find in deaths from burns, the appearances described by Dupuytren, *see* above, or suppurating or sloughing surfaces due to these. *Serum will in most cases be found in all the serous cavities* in abnormal quantity [ventricles and base of brain, pleuræ, pericardium, abdominal cavity, &c.]. *The mucous membranes of the bronchi and alimentary canal will generally be much congested.* So will the lungs, and very often the liver and kidneys, and even the pelvic organs. The duodenum, œsophagus, and ileum, should be specially examined. Dr. Taylor refers to cases in the "Medical Gazette," vol. xxv., p. 743, and vol. xxxi., p. 551, to the "American Journal of Medical Sciences," January, 1861, p. 137; "Lancet," 1863, vol. i., page 60 (Dr.

Buzzard's case), Dr. Mendel's cases in Horn's "Vierteljahrschrift," 1870, 2, p. 93, and Dr. Wilks, in "Guy's Hosp. Rep.," 1860, No. 6, p. 146, for accounts of post-mortems. The subject is treated of at some length in "Holmes' System of Surgery," and in most works on surgery. *See* also the Medical Journals *passim.* With regard to the appearances on the skin in cases of burns, it is generally conceded that *a line of redness* surrounding the dead white of the skin of the burnt part, is a sign that the burn was inflicted during life. This red line is not to be confounded with the diffused redness which disappears after death; that is a capillary congestion or erythema, but this *line of redness* is like that seen in gangrene, a line of demarcation between the living and dead tissues, and is seen after death. The experiments of Sir R. Christison, Dr. Taylor, and others showed that it could not be produced more than a few minutes (less than ten) after death. M. Champouillon indeed asserts that he has produced it easily in dead bodies, but he describes a much slighter and more superficial redness. The true line is the result of vital reaction [*see* the "Ann. d'Hygiène," vol. i., p. 442]. The presence of granulations [exuberant ones are called "proud flesh"], pus, gangrene, and the like in the burnt portions of the body would be *proof positive* that the sufferer from the burn had lived for some time after. Mr. Curling found the ulcers previously described about the tenth day in most cases, at all events in the second week. You may be asked in the course of an inquest or trial:—

Can vesications, or blisters, be produced in a dead body by fire, boiling liquids, or hot metals, &c.?

It is usually supposed that the presence of vesications is a proof of the burn having occurred during life. And in ninety-nine cases out of a hundred it is so. Hence hot sealing-wax has been proposed as a *test for death* [*see* page 18, Minor Signs of Death]. Scalding liquids, flame, hot metals, and other means which do not destroy the skin, cause the exudation of serum, sometimes in a moment almost, at other times *in a few minutes,* or after some hours. The serum exuded from the blood raises and distends the cuticle. But owing to the delay just mentioned, the sufferer may die before the blister rises. The question asked above confuses *somatic,* or general death of the body, or of the individual, with the *death of the tissues,* or particular parts of the organism which may be, and often is, delayed for a time. Sir R. Christison was one of the first to give us facts on this subject. He tried the effect of a hot iron on the outside of the hip-joint, in a young man comatose from opium; and, half an hour after the youth died, a red hot poker was applied to three places on the inside of the arm. In both cases blisters formed, but in those produced during life there was *serum,* in those caused after death there was only *air.* He also experimented on an amputated leg: half an hour after it was cut off, no blisters could be got from it by using a hot iron; but, ten minutes after amputation, blisters containing air were formed easily. Christison therefore concludes that *serum* in a blister indicates its formation in life, whilst *air* in a vesicle means that it was caused after death. Dr. Taylor, Ollivier, and others (*loc. cit.,* p. 690, and "Ann. d'Hygiène," 1843, i., p. 383), both failed to get blisters eighteen and twenty hours after death. In the body of a man just drowned, put into too hot a bath, Dr. Taylor found besides the skin separating easily that there *were several blisters* (vesications) *filled with bloody serum* produced, especially on the legs. Champouillon, Leuret, the late Dr. Wright (of Birmingham), and others, all state that they have easily produced these blisters in dead bodies, *even as long as twenty-four hours after death.* But Dr. Taylor notes that *most of these were dropsical subjects—or the bodies had preserved their warmth, and were still supple and flexible.* Liman experimented on three dead bodies, and could only get air or gas in the blisters produced. More recently Dr. Chambert has made many experiments on both the living and dead bodies, up to twenty hours after death. He concludes that within that period, vesications or blisters may usually be produced on the dead body, and at even a lower temperature than in the living, but that the serum contained, instead of being thick, and strongly coagulable by heat or nitric acid, like that of blisters formed in life, is thin, watery, and scarcely coagulable at all—turning, perhaps, a little milky.

The authors experimented on some twenty to thirty bodies, from one or two hours to five or six days after death; also on several amputated limbs. In the latter, blisters could hardly ever be obtained longer than from twenty to thirty minutes after amputation, probably owing to the rapid cooling. In the dead bodies they never succeeded in getting any vesication or blistering after the first eighteen hours, rarely after twelve hours. They conclude. therefore, as follows :—

1st. In the great majority of cases, blisters, or vesications, are produced during life—at all events no authentic instance is known of their occuring on the second day after death—in other words, if not formed whilst the person was alive, they must be formed during the life of the tissues.

2nd. The probability of the blisters having been formed in life, is enormously increased if we find them containing thick serous fluid, rich in albumen. On the contrary, if they only contain air or gas, or a very thin fluid, poor in albumen, they have in all human probability been formed after death.

When there are *several burns* on a dead body, you may be asked, "*Were all these burns inflicted at one and the same time?*" To answer this question, you must notice if any of them have begun to suppurate, or slough (become gangrenous), or cicatrize, or show any other of such changes as indicate vital action. But burns inflicted at the same time may not all heal with equal rapidity, owing to their degree, or to some peculiarities of circulation or innervation, the situation of the burn or scald, and its extent, and sometimes to the mode of treatment.*

Dr. Guy calls attention to the fact that badly nourished people

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* On the question of burns, &c., in the dead body, and the production of vesicles, see Chambert ("Annales d'Hygiène," April, 1859); Christison ("Edinburgh Medical and Surgical Journal," vol. xxxv.. p. 320); Leuret ("Annales d'Hygiène," 1835, 2, 387); Champouillon ("Annales d'Hygiène," 1846, 1, 421); Wright ("Pathological Researches on Vital and Post-Mortem Burning," 1850); "Annales d'Hygiène," 1859, 1, 342; Casper ("Vierteljahrschrift," 1863, 24, 367); Casper ("Dr. Balfour's Translation," vol. i., p. 299, &c.); Dr. Stone's (of Boston) report of the trial of Dr. Webster for the murder of Dr. Parkman, 1850; the trial (*Reg.* v. *Newton*) for matricide, at the Shrewsbury Lent and Summer Assizes, 1849; and the systematic works of Beck, Taylor, Guy, and other writers, on Medical Jurisprudence.

(sufferers from phthisis, starvation), may present blisters, etc., on the body or extremities not unlike those produced by fire—without, however, any fire or boiling liquid having been applied. Such blisters, and sores left by them (so-called "burnt holes"), were, alas, too common in the great Irish famine due to the potato blight. Mr. Curling met with a case which he communicated to Dr. Taylor, in which the dead body of a burnt child, aged two years, had wounds, which were, in fact, gaping holes, on both knees, which, at first sight, it seemed unlikely could have been caused by fire alone. But careful examination of the wounds made him attribute them to the flames, and not to any other cause. The action of the muscles had no doubt assisted. [Taylor, *loc. cit.*, p. 696.]

Illustrative Cases.

CASES I. AND II.—*Murder of Six Husbands by Melted Lead.—The Reputed Origin of Coroner's Inquests.*

The following anecdote is often told. We have been unable to trace it to a more ancient source than the "Dictionnaire d'Anecdotes," &c., published by La Combe, Paris, in 1766, although it refers to the time of King Edward the First. The book says (p. 361), "A pretty citizeness of London had had six husbands, one after the other: the first to please her parents, the rest to please herself. One of her countrymen was brave enough to allow her to make him her seventh husband. For a few months all went merrily. Her fondness, perhaps, made her indiscreet. She told her husband all the faults and follies of his predecessors. She disliked some because they were sots, others because they were unfaithful to her. In short, she had no good words for any of them. The husband, suspecting something, and wishing to test the character of his wife, began to stay out late, and to appear drunk when he returned. She first reproached him, then began to threaten; but he continued to stop out late, and to feign drunkenness, even more often than before. One night, when she believed him dead drunk, and fast asleep, she took a lead button from the sleeve of her dress, melted it in a pipe, and approached the pretended sleeper, to pour the melted metal into his ear. The husband, no longer doubting her guilt, seized her, cried for help, and gave her up to justice. She was first imprisoned, and then tried, the dead bodies of her six husbands being exhumed, and all bearing witness against her, by the discovery of lead in their ears and brains. On this evidence she was condemned to death. Hence the origin of coroner's inquests in England."

A similar case is recorded in the "Annales d'Hygiène," 1847, 2, 424, by M. Boys de Loury. The mother of an idiot, aged twenty-five, tried to get rid of him, by pouring melted pewter into his right ear, whilst he was asleep. Great pain and violent inflammation followed, but he recovered. She declared he had done the deed himself. The alloy was said to be composed of seven parts of *tin*, and three of *lead*, with a melting point of about 340° F. (171·1° C.) In performing some experiments on the dead body, M. de Loury found that it was difficult to fill the auditory canal with such an alloy, because the high temperature caused a sudden expansion of the air. A similar case with strong nitric acid has been mentioned at p. 989.

CASES III. TO IX.—*Bodies Murdered first, and Burnt afterwards.*

[Beck, *loc. cit.*, p. 523.]

"Foderé relates (vol. iii., p. 18) the case of a wretch who murdered several individuals with an axe in 1809, and then set fire to the house. The medical officer did not deem it worth while to examine the bodies, and certified that their death was due to the fire. Meanwhile an individual was discovered murdered about one hundred paces from the house, and suspicion being excited, the bodies were disinterred. It was found that the flames had only burnt the flesh superficially, and that the marks of the axe were still distinctly visible. Dr. Dunlop (MS. Lectures) mentions a similar case occurring at Glasgow in 1809. A man murdered his wife, and then set fire to her clothes. There were, however, marks of external violence sufficient to convict him." "So also in the State of Maryland, a few years since, a ruffian murdered a whole family, and then fired the log-house in which they lived. On the body of the father, however, a fracture of the skull was found; and in consequence of a bed from the upper room falling on the mother, her body was so far uninjured as to exhibit three incised wounds, one of them penetrating the stomach."

The murderer was detected by finding on him articles of dress belonging to the family. Other cases of the kind are mentioned by Beck and Taylor. From the latter (*loc. cit.*, p 692, &c.) we extract the following references:—

Case of *Dr. Prince of Uckfield*, March, 1848. Two persons were charged with murder of a new-born child, whose body was also burnt. Drs. Prince and Taylor concluded the child had been burnt alive. The woman confessed it was so.

In Mr. Paas' case (*Rex* v. *Good*), and in that of *Reg.* v. *Good*, and one at Leeds in January, 1843, the murder was probably committed first, the burning done after. So in Dr. Parkman's case; see reference in foot note to p. 995.

In *Reg.* v. *Taylor* (York Lent Assizes, 1842), the deceased had marks of strangulation on her neck, and her clothes were much burnt from the waist to the knees. She was lying across the hearth. The medical witness denied that there could be burns without vesication following!

CASE X.—*Attempted Murder by Burning with Petroleum.—Death on the Second Day.*

[Dr. Taylor, *loc. cit.*, p. 695.]

"In *Reg.* v. *Gaitskell* (Carlisle Spring Assizes, 1872), the prisoner was convicted of manslaughter under the following circumstances:—He poured a quantity of petroleum over the clothes of the deceased, and by accident the vapour caught fire, and the burns produced caused the man's death on the following day." Although it is said the clothes caught fire by accident, it is well known that much of the so-called *petroleum*, or *American Rock-oil*, will emit a vapour, firing considerably under 100° F. [= 38° C. nearly]. See Petroleum and other inflammable substances, under Spontaneous Combustion, at the end of this chapter.

CASE XI.—*Suicide Attempted by means of Fire.*

(Taylor, *loc. cit.*, p. 695.)

"A case of this kind occurred in Newgate in December, 1871. One of the prisoners was found in his cell with his clothes, and part of the bed-clothes, much burnt, and with some severe burns on the body. The gaslight in the cell was so placed that no accident could account for the fire; but all the facts concurred to show that the man had done the act deliberately. He gave no alarm, but a moaning was heard in his cell, and this caused the warder to enter and make the discovery in time to save him."

CASES XII. TO XV.—*Boiling Water used with intent to Murder (?)*

[Taylor, *loc. cit.*, p. 697.]

"At the Liverpool Summer Assizes, 1847, a woman was convicted of throwing boiling water over her husband with intent to *maim* him (*Reg.* v. *King*). In another case (*Reg.* v. *Blewitt*, Worcester Summer Assizes, 1847), prisoner was convicted of the manslaughter of his wife by pouring over her the contents of a kettle of boiling water. At the Stafford Winter Assizes, 1859 (*Reg.* v. *Hill*), a man was convicted of feloniously casting boiling water over the prosecutor 'with intent to do him grievous bodily harm.' The medical evidence was to the effect that the scalds were on the head, cheek, neck, and arm, and were of a dangerous character. A woman at Glasgow endeavoured to kill her husband by pouring boiling water over his genital organs while he was asleep in bed. He died, but his death could not be clearly traced to this cause."

On the Comparative Immunity to Burns and Scalds and Great Heat, evinced by certain persons, Conjurors, &c.

It may not, perhaps, be matter for great surprise that the human body, as mentioned at page 978, will bear extraordinary degrees of heat for a short time, as exemplified by Chabert, *the fire-king*, and by the workmen and workwomen in potteries, glasshouses, ironworks, &c. But the feats shown by workmen, and sometimes by public exhibitors, as to the handling of red-hot metal, burning coals, and the like, are so marvellous that they might be disbelieved were there not an explanation forthcoming, to a certain extent, in the so-called *spheroidal ebullition of liquids*. "M. de Boutigny showed, at the meeting of the British Association at Ipswich in 1851, that a hand which is naturally damp, or which has been slightly moistened, may be safely passed into the stream of *molten iron* as it flows from the furnace. For in all such cases a thin film of aqueous fluid in the spheroidal state intervenes between the skin and the heated surface." Carpenter's "Physiology," note to p. 484. The ancient trial by the *ordeal* of the *hot ploughshare* may thus be explained; though it is to be feared that the more guilty, the more likely to escape, unless indeed fear made the skin dry, hot, and parched, instead of moist. See article Spheroidal State in the "Popular Encyclopædia."

SPONTANEOUS COMBUSTION.

Certain mineral, vegetable, and animal substances appear really to be prone to *spontaneous combustion.* In other words they fire without any light or spark being put to them. What are called *pyrophori* are examples of this. One of the most celebrated of these, the *pyrophorus of Homberg,* is a mixture of dried alum and sugar, carbonized in an open pan, and then heated to redness in a glass flask, contact with air being avoided. It ignites spontaneously on exposure to the air. The tartrates of lead and of iron, and Prussian blue heated to redness and then cooled, without contact with air, and enclosed in glass tubes, fire as soon as the tubes are broken, and the finely divided metallic compounds immediately ignite. They are conveniently made by heating these tartrates in a glass tube in a stream of coal-gas or of hydrogen, which decomposes the salt, leaving the metal in a state of very fine division. The tube is sealed whilst hot. On shaking the contents of the broken tube into air, or a jar of oxygen gas, the particles of the metal are oxidised with the evolution of heat and light. The so-called *Greek fire* is a solution of *phosphorus* in *bisulphide of carbon* or in *ether.* It was said to be largely used in the siege of Charleston during the late civil war in America.

Among heaps of rags, cotton, and other substances strongly lubricated with oil (cotton waste, sheep's wool, &c.), a process of spontaneous combustion often occurs, the first stage of which appears to be a sort of heating, not unlike fermentation. Hay-ricks, and ricks of corn, and other cereals, not seldom fire in this way. Fresh-burnt lime, when moistened with water, slakes with great violence, evolving heat, and crumbling to a soft white bulky powder, which is a hydrate containing a single molecule of water: the latter can be again expelled by a red heat. This hydrate has the composition CaO, H_2O. So great is the heat evolved in the lime-carts by a shower of rain that they not seldom catch fire. Spontaneous combustion of a quantity of hemp is said, but not proved, to have been the cause of the recent terrible fire in Tooley Street; whilst ships, laden with coal impregnated with iron and sulphur in the form of bisulphuret of iron (iron pyrites), are said to catch fire by the access of moisture (especially in the tropics) occasioning such intense heat as to cause the combustion of the coal, especially when air is admitted by opening the hatches. Several fires occurred both in warehouses on shore, and in the Russian navy, towards the close of the last century, which were at the time attributed to the acts of incendiaries. It was subsequently discovered that they were owing to the spontaneous heating and ignition of large quantities of flax and hemp impregnated with oil or grease. Jute is another substance liable to this kind of thing. Experiments were made on the subject on a large scale by the Imperial Academy of Science, and the result was to satisfy the inquirers not only as to the possibility but of the actual occurrence of spontaneous combustion [Paris and Fonblanque's "Medical Jurisprudence," vol. i., p. 410. *See* also the "Ann. d'Hygiène," 1841, 1, 364]. The great fire in Plymouth Dockyard in 1840, says Dr. Taylor, was supposed to have originated from a similar cause, though others attributed it to design. He also states that an injunction was lately sought against certain merchants for the stowage and drying of jute on premises in the vicinity of which there was much valuable property, for a similar reason. Some gases, such as the silicide of hydrogen (silicum hydride), or silicated hydrogen ($Si H_4$), and phosphuretted hydrogen (PH_3), also fire spontaneously on exposure to air. The latter is said by M. Paul Thènard to arise from the presence of the vapour of a liquid hydrogen phosphide (PH_2). This substance forms a colourless liquid of high refractive power, and very great volatility. It does not freeze at 0° F. (—17·8 C.), but in contact with air it inflames instantly, and its vapour in very small quantity communicates spontaneous inflammability, not only to pure phosphuretted hydrogen, but also to all other inflammable gases. The *Will o' the Wisp* is supposed to be formed of this gas. Many other gases, when mixed with air, form easily exploded and inflammable gases. *Methane*, or marsh-gas, light carburetted hydrogen, *firedamp*, are all names given to CH_4: it forms a frightfully explosive gas when mixed with ten volumes of air or two volumes of oxygen; which has been the cause of almost innumerable accidents in collieries and other mines.

Coal-gas, which has been already explained to be a mixture of several gases, the chief of which are light and heavy carburetted hydrogen, and carbon monoxide, is also very explosive when mixed with air. So are many vapours, particularly those of ether and bisulphide of carbon, and the vapours given off at various temperatures from different kinds of *paraffin-oil, petroleum, and other rock oils.** *It is found by experience that it is not safe to use paraffin oil which will take fire on the application of a match and burn continuously at a temperature below* 100° *F.* (37·7° C.) [See Fowne's Chemistry, pp. 545-552, and Thorpe and Young in the "Berichte der Deutschen Chemischen Gesellschaft," 1872, p. 536, and Schorlemner in the "Proceedings of the Royal Society," xvi., 34, 367.]

In 1873 the petroleum or rock-oil imported into this country was, from the United States, unrefined, 895 tuns, value £12,836; refined, 16,377,252 gallons, value £974,755; and 58,548 gallons of refined from other countries, value £4,250. Several Acts of Parliament have been passed to regulate the traffic; that now in force is the 34 & 35 Vict., cap. cv., passed 21st August, 1871. Petroleum must not be kept in quantity without licence from the local authorities; nor must it be sent by any conveyance, either by land or water, without being labelled in conspicuous characters, and the label must contain the name and address of the sender, as well as that of the consignee. Besides penalties, the petroleum also is forfeited when these regulations are not complied with.

Pure *hydrogen* gas is a very dangerous and explosive compound when mixed with a little air. The Authors know of several medical men and chemical pupils, who have lost the sight of one eye, or been otherwise injured by the neglect of precautions in dealing with this gas.

Other Explosive Bodies.

There are a large number of bodies used in the arts for blasting, quarrying, and other purposes, or for sporting and warlike purposes, which nearly all contain nitrogen loosely combined. The wounds produced by these will be separately dealt with in the next chapter, but some mention of them seems appropriate in this place. One of the earliest known and the most used is *gunpowder*, with the invention of which the Chinese are credited. The Arabs appear to have known of it, for, in A.D. 1331, the Moors are said to have used it in siege operations before Alicante, and certainly in 1342 at Algeciras. In 1250 the Arabs probably used a mixture similar to gunpowder before Damietta, and perhaps also in a naval engagement in 1085. The *Greek fire* used in 668 must at least have contained saltpetre (potassium nitrate) mixed with pitch, naphtha, &c., since it was customary by its means to hurl stones from metallic tubes. The earliest knowledge of Europeans in regard to the chemical mixture of powder is found in the ninth century, in a book composed by Marcus Græcus, preserved in the University of Oxford, which also accurately describes its composition. Roger Bacon (died 1294), who is usually credited with the discovery, was most certainly acquainted with its composition and some of its properties. But Berthold Schwartz, a monk who lived at Mayence between 1290 and 1320, is supposed to have first made known its use in gunnery. English records have been brought to light, testifying that some kind of gunpowder (*pulvis pro ingeniis*) was shipped for La Hogue (the Hague), by the officers of King Edward III., and there landed, in June or July, 1346. It is therefore almost certain that it was used at the battle of Crécy. The proportions of the constituents in various kinds of gunpowder differ somewhat. The following may serve as samples :—

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* A great number of names are given to these. *Kerosene* is the name commonly given in Australia and the States to petroleum. Petroline is another synonym.

	Russian powder mills.	French and Prussian do.	Waltham Abbey Royal Mills.	Theoretical proportions.
Saltpetre .	73·78	75	75	74·8
Sulphur .	12·63	12½	15	13·3
Charcoal .	13·59	12½	10	11·9

For the processes employed in the manufacture we must refer to technical works. The *grain* or size of the powder varies with the purposes for which it is used: a large grain is adapted for large and heavy charges, and for purposes of blasting. *Pellet* powder is in small short cylinders or pellets, with a cavity at one end to easily catch flame. *Pebble* powder is at first in small cubes, which have their corners rounded off by friction. All powder is finally dusted and glazed. Service powder is classified according to the size of the grain, the letters L.G., F.G., R.L.G., R.F.G., signifying large grain, fine grain, large rifle grain, fine rifle grain, &c., &c. If powder is heaped up in the open air and then inflamed, it detonates with little report or effect. Placed loose in a room, a small quantity fired merely blows out the windows, but the same quantity, when confined in a bomb in the same chamber, and inflamed, tears in pieces and sets on fire the whole house. In one of Count Rumford's experiments, he took less than a dram of gunpowder (about $\frac{1}{20}$ of an ounce), and loaded a mortar with it, placing upon it a twenty-four pound cannon, weighing 8,081 pounds ; he then closed up all the openings as perfectly as possible, and fired the charge, which burst the mortar with a tremendous explosion, and raised up this enormous weight. Mr. Robins, Engineer-General to the East India Company, calculated, from his experiments, that the weight of the vapour of gunpowder was about $\frac{1}{10}$ of the weight of the powder yielding it, and 244 times its bulk, when allowed to expand to an elasticity equal to that of the atmosphere. To this expansive force of the gas evolved from the powder, we must add the effect of the heat raised during the combustion, which will at the very least increase elasticity four times, making the elastic force 1000 atmospheres, in round numbers; which, at the ordinary pressure of the atmosphere, will make the force of the gas of confined gunpowder a pressure of about six and a half tons to each square inch. There are a number of complex chemical decompositions; and it was formerly supposed that when gunpowder is fired, the whole of the oxygen of the potassium nitrate was transferred to the carbon, forming carbon dioxide, the sulphur combining with the potassium, and the nitrogen being set free. There is no doubt that this reaction does take place to a considerable extent, and that the large volume of gas thus produced, and still further expanded by the very high temperature, sufficiently accounts for the explosive effects. But recent investigations by Bunsen, Karolyi, and others, have shown that the actual products of the explosion of gunpowder are much more complicated than this theory would indicate, a very large number of products (including compounds of nitryl, or NO_2, *see Gun-cotton*) being formed, and a considerable portion of the oxygen being transferred to the potassium sulphide, converting it into sulphate, which, in fact, constitutes the chief portion of the solid residue and of the smoke formed by the explosion.* [*See* Watt's "Dictionary of Chemistry," vol. ii., p. 958]. Besides saltpetre or nitre KNO_3 [= NO_2 (OK)] other potassium salts, as the chlorate ($KClO_3$) and the picrate ($C_6H_2K(NO_2)_3O$), are very explosive, the latter being used for Orsini-bombs, &c., the former for lucifer matches. *Time fuses* are generally made of string, paper, or other materials strongly imbued with saltpetre. The sale and storage of gunpowder have been regulated by Acts of Parliament ever since the time of King Charles I. The various laws have been consolidated by 23 & 24 Vict. cap. cxxxix., 28th August, 1860, by which former Acts were repealed. The sale of fireworks without a licence, or to persons under sixteen years of age, and the throwing of fireworks in public thoroughfares, are also prohibited, under penalty of £5. No dealer is to have more than 200 lbs. of powder at one time, nor other person more than 50 lbs. in any one building, either on land or water, except in vessels loading or unloading, &c. Limited quantities only are to be sent by any conveyance. The Act 24 & 25 Vict. cap. cxxx., 6th August, 1861, extends the provisions of the previous Act to makers of patent fuses. The 25 & 26 Vict. cap. xcviii., 7th August, 1862, includes the making of percussion caps, fireworks, &c., within the provisions of the principal Acts; whilst the exportation of gunpowder may be altogether prohibited by order of Queen in Council, under the 45th section of the Customs Consolidation Act, 16 & 17 Vict. cap. cvii. The colours of fireworks are due to strontia, baryta, antimony, and other metallic admixtures, which do not sensibly increase the danger. So dangerous and explosive is gunpowder when nearly dry, that all metal articles of dress, such as buttons, nails in shoes, and the like, are forbidden in powder magazines. Glass, in small particles, mixed with gunpowder, prevents its explosion: this process has been patented. When required for use the glass is sifted out. Iron is far more dangerous than copper, hence the use of copper hoops and copper bolts for powder casks. In the service, *red* [as the signal of danger] is employed to indicate powder stores and magazines.

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* It requires a temperature of about 525° F. = 273·8° C. for complete combustion.

Gun-cotton is a substitution product, formed from cotton-wool by dipping it, or rather steeping it, in concentrated nitric acid; in practice a mixture of strong sulphuric and nitric acids is employed. When all the acid is thoroughly washed away, and the cotton dried by a gentle heat, it is found to have increased in weight about 70 per cent., and to have become highly explosive, taking fire at a temperature of not much more than 149° C. (= 300° F.), and burning without smoke or residue. This is *pyroxolin*, the gun-cotton of Schönbein. Paper, sawdust, starch, and similar substances treated in this way, become very highly combustible. Several varieties of pyroxylin are known, distinguished by their different degrees of stability and their solubility in alcohol, ether, and other liquids. According to Hadow,* the three principal varieties are:—

(*a*) $C_{18} H_{21} (NO_2)_9 O_{15}$, or $C_6 H_7 (NO_2)_3 O_5$, insoluble in a mixture of ether and alcohol, but soluble in ethylic acetate. It is produced by the repeated immersion of cotton-wool in a mixture of two molecules of nitric acid, $H NO_3$, two molecules of oil of vitriol, $H_2 SO_4$, and three molecules of water.

(*β*) $C_{18} H_{22} (NO_2)_8 O_{15}$, soluble in ether-alcohol, insoluble in glacial acetic acid. Produced when the acid mixture contains half a molecule more water than in (*a*).

(*γ*) $C_{18} H_{23} (NO_2)_7 O_{15}$ (Gladstone's *Cotton* xyloïdin), soluble in ether, and in glacial acetic acid. Produced when the acid mixture contains one molecule more water than (*a*).

The first of these, which consists of *trinitrocellulose*, is the most explosive of the three, and the least liable to spontaneous decomposition. It is the only one adapted for use as an explosive agent, and is especially distinguished as *gun-cotton*. From experiments of General von Lenk, of the Austrian service, it appears that to insure the uniform production of this particular compound, the following precautions are necessary:—

1. The cleansing and perfect drying (dessication) of the cotton prior to its immersion in the mixed acids.
2. The use of the strongest acids procurable in commerce.
3. The cotton must be steeped in a fresh strong mixture of acids after its first immersion and partial conversion into gun-cotton.
4. This steeping should continue for forty-eight hours.
5. The gun-cotton thus far made must be thoroughly purified and cleansed from every trace of free acid, by washing the product in a stream of water for several weeks. Subsequently a weak solution of potash is advised by some to be used; but this is not really necessary.

The less highly nitrated compound, dissolved in alcohol (with the addition of some ether), is called *collodion.* It is used in surgery, as you are all aware; and largely used by photographers, as, on drying, the evaporation of the alcohol and ether leaves a thin, transparent, adhesive membrane on the glass, which is in fact a species of paper.

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* "Chemical Society's Journal," vol. vii., p. 201. See also Professor Abel's papers in the "Proceedings of the Royal Society," vol. xv., p. 182, and "Chemical Society's Journal" (2), vol. xv. p. 310; and "Fowne's Chemistry," p. 657-8.

Gun-cotton has already caused some deaths by the explosion or combustion of the manufactured product, some of which were due to ignorance of the varieties above named. One such occurred to the great private manufacturers, Messrs. Prentice of Stowmarket; and two of the firm met their own death by endeavouring to prevent an explosion. *Gun-cotton* has about four times the explosive power of *gunpowder.* By the application of detonating force, gun-cotton can be made to explode when quite wet, and therefore incapable of being fired. *In short, when wet it is quite safe from fire, and yet ready for work at a moment's notice.*

Nitro-glycerine, which has been mentioned at p. 532, amongst the poisons, may be regarded as glycerine, in which the three hydrogen atoms of the OH groups are replaced by the radical of NO_2. Thus :—

$$C_3\ H_5\ (O\ H)_3 = \text{glycerine, whilst}$$
$$C_3\ H_5\ (ONO_2)_3 = \text{nitro-glycerine.}$$

It is a yellow, oily liquid, heavier than, and insoluble in water, but dissolved by alcohol, ether, and other solvents, which precipitate it on the addition of water. It is made by adding to 350 parts by weight of glycerine, 2800 parts by weight of a cooled mixture of three parts of sulphuric acid of 1·767 sp. gravity, and one part of fuming nitric acid. Great care must be taken by means of ice, or freezing mixtures, to avoid rise of temperature during the operation. The liquid is poured into five or six times its bulk of cold water, when the heavy nitro-glycerine sinks to the bottom. When violently struck, nitro-glycerine, or *glonoin,* explodes, being resolved into water, carbonic acid, nitrogen oxides, and nitrogen gas. The volume of gas produced is about 10,000 times the initial volume of the nitro-glycerine. The detonation seems to be due to the sudden transformation of the motion of the striking body into heat; before this heat can be equally distributed throughout the mass of nitro-glycerine, it is able to raise some of the particles of that substance to the temperature (190° C. = 374° F.) at which they suffer decomposition—the shock of this partial decomposition is propagated to adjacent particles, from which it is conveyed to others, and so on. The same effect may be produced by heating a portion of the mass. Its explosive force is about thirteen times that of gunpowder. If a little acid has been allowed to remain in it, it will undergo decomposition spontaneously. It has lately come largely into use in quarrying, mining, and engineering operations, such as tunnelling, blowing up wrecks, and also in torpedoes. *Dynamite* was patented by A. Nobel in 1867; it consists of a siliceous earth from Oberlohe in Hanover, known as *Kieselguhr,* impregnated with 75 per cent. of nitro-glycerine. The siliceous matter is of diatomaceous origin, extremely friable and porous, and has a considerable absorbent power. The mixture remains unchanged for any length of time, and is not exploded by mere shock, but requires to be exploded by specially-prepared *fulminating caps.* [See *Percussion caps.*] Thrown into a fire, it burns with a bright flame, but without explosion. Its explosive power is reckoned as about eight times that of gunpowder. It is also more concentrated. It is superior to blasting-powder in mines, because not affected by damp, being more economical, and giving off no smoke. Various substitutes for this siliceous earth, such as charcoal, sand, and sawdust, have been adopted. That made at Paris during the recent siege is said to have consisted of 25 per cent. of nitro-glycerine, and 75 per cent. of burned clay, from the glass and brick furnaces. It was used with great effect in breaking up the accumulations of ice on the Seine. [See article *Dynamite* in "Popular Enclyclopædia."] From its great disruptive power, wounds caused by dynamite will probably be very rugged and severe, as well as often appearing contused. A prepared sawdust, probably a variety of pyroxilin, is now used by sportsmen, in lieu of gunpowder. When used in the right proportions, the gun is said not to "kick." In other words the recoil is slight.

Percussion caps, whether used for large or small fire-arms, or for firing explosive charges in mines, &c., are now nearly always composed of *fulminates*. Some few may contain chlorate of potash, sugar, sulphur, phosphorus, and other ingredients used in making matches,* but the vast majority are composed of either *fulminate of mercury*, or *fulminate of silver*, or some of their compounds. They all contain *fulminic acid*, which is bibasic, and represented by the formula $C_2\ N_2\ H_2\ O_2$, or $C_2\ (N_2O),\ H_2\ O$, which is polymeric with cyanic and cyanuric acids, and originates in the peculiar action exercised by nitrous acid upon alcohol in the presence of a salt of silver, or mercury, &c.

Silver fulminate is prepared by dissolving forty or fifty grains of silver in about three-quarters of an ounce by measure of nitric acid of sp. gr., 1·37, with the aid of a little heat. To the highly acid solution, while still hot, two measured ounces of alcohol are added, and heat applied until reaction commences. The *nitric* acid oxidises part of the alcohol to aldehyde, and oxalic acid, becoming itself reduced to *nitrous* acid, which in turn acts upon the alcohol in such a manner as to form nitrous ether, fulminic acid, and water ; 1 molecule of nitrous ether, and 1 molecule of nitrous acid containing the elements of 1 molecule of fulminic acid, and 2 molecules of water ; thus—

$$\underbrace{C_2H_5NO_2}_{\text{Nitrous Ether.}} + \underbrace{HNO_2}_{\text{Nitrous Acid.}} = \underbrace{C_2N_2H_2O_2}_{\text{Fulminic Acid.}} + \underbrace{2\ H_2O.}_{\text{Water.}}$$

The silver fulminate slowly separates from the hot liquid in the form of small, brilliant, white crystalline plates, which may be washed with a little cold water, and dried cautiously in a warm place. The only perfectly safe way of keeping it is to immerse it in water. It is soluble in thirty-six parts of boiling water, but nearly all crystallises out on cooling. It is one of the most dangerous substances known, exploding with fearful violence when strongly heated, or when rubbed or struck with a hard body ; or when touched with concentrated sulphuric acid, the metal is reduced, and a large volume of gaseous matter suddenly liberated. Strange to say, when very cautiously mixed with copper oxide, it may be burned in a tube with as much facility as any other organic substance. Its composition thus determined is expressed by the formula $Ag_2\ C_2\ (N_2\ O)\ O$, or $Ag_2\ C_2\ N_2\ O_2$.

There is a *silver potassium fulminate* = $AgK\ C_2\ N_2\ O_2$, which also detonates by a blow. Corresponding sodium and ammonium compounds exist. If a silver fulminate be digested with water, and copper or zinc, the silver is displaced, and a fulminate of zinc or copper produced.

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* The following is said to be the "composition" most matches are dipped into :—"Phosphorus (say), 4 parts ; nitre, or chlorate of potassium, 10 parts ; fine glue, 6 parts ; red ochre, or red lead, 5 parts ; and smalts, 2 parts." In *safety matches* the phosphorus is on the box.

There is a zinco-baric fulminate = $Zn'' Ba'' (C_2N_2O_2)_2$. And a *Mercuric fulminate* $Hg'' C_2N_2O_2$, which is prepared by a process very similar to the one given for the silver salt. [See Fowne's "Chemistry," p. 862-4.] Its properties are very similar to the silver fulminate. It explodes violently by friction or percussion, but, unlike the silver salt, merely burns with a sudden and almost noiseless flash when burned in the open air. It is manufactured on a large scale for the purpose of charging *percussion caps ;* sulphur and potassium chlorate, or more often nitre, are added ; and the powder, pressed into the cap, is secured by a drop of varnish.

Aurum fulminans [which Beckman, in his "History of Inventions," says was known to the older alchymists] is said by Berzelius to have the composition of $Au_2 O_3$, 4 NH_3, $H_2 O$. It is formed by digesting auric oxide $Au_2 O_3$ in ammonia.

The *oxide* of silver, and its *oxalate,* and other silver and mercury salts, are capable of sometimes detonating with considerable force. The oxide of silver is particularly prone to explode, when prepared from the nitrate and precipitated by ammonia.

The *teriodide of nitrogen* (NI_3), prepared by putting iodine into ammonia ; and the terchloride of nitrogen (NCl_3), prepared by inserting a jar of chlorine into a solution of nitrate or chloride of ammonium, are very dangerous and explosive substances. The latter explodes between 93° and 105° C., with most fearful violence (= 199·4° and 221° F.). It is a deep yellow and very volatile liquid, whose vapour irritates the eyes. It has a sp. g. of 1·653, and may be distilled at 71° C. (160° F.), though not without extreme risk. Contact with almost any combustible matter, such as oil or fat of any kind, determines the explosion at common temperatures. It is now believed to contain some hydrogen (instead of NCl_3, it may be $NHCl_3$ or $NH_2 Cl$). As may be imagined, its analysis is not easy.

The former also is supposed by Gladstone and others to contain NHI_2, or by Bunsen to be NI_3, NH_3. But its composition probably varies.

Berthollet's fulminating silver is formed by digesting argentic oxide $Ag_2 O$ in ammonia. While moist it explodes only when rubbed with a hard body, but when dry the touch of a feather is sufficient.

There are other explosive bodies known to chemists, but those named are most commonly met with. We are thus brought to the conviction that there are a large number of substances whose component elements are loosely combined, and ready to form other compounds. Yet there are many reasons which make scientific witnesses unwilling to believe in the spontaneous occurrence of combustion in the case of large fires, such as that of London Bridge in 1861, attributed to the spontaneous combustion of jute in its ordinary state, for, as Dr. Taylor says, this jute had already borne a long sea-voyage. Again, in the City Flour Mills in Thames Street, in November, 1872, Captain Shaw stated that although the fire was supposed to originate in the heating of damp sacks, several of these were burned on the *outside,* and not in the middle. It was also found that a number of idle persons were on the premises that afternoon, and one of them, who had a box of lucifer matches, was intoxicated.

Again, Dr. Taylor says, the heat is not likely to reach 1000° F. (537·7°), unless large quantities are accumulated. The Authors know, however, of an instance, in a private surgery, where there was no reason to suspect any one of arson, in which the contents of a drawer consisting of only a few greasy woollen and cotton rags ignited. Yet Dr. Taylor remarks, although it may be true, as Chevallier states, in the "Annales d'Hygiène" for 1841, 1, p. 276-309, &c., that wood which has decayed, and is then dried in an oven, is as inflammable as a pyrophorus, and that pine or other resinous woods, long exposed to temperatures above that of boiling water, become highly combustible ; yet, on the other hand, it has never been proved that they will take fire below their igniting temperature in air (1000° F. = 537·7° C.). Dr. Taylor says "he has exposed the thinnest deal shavings in contact with iron pipes at temperatures varying from 150° to 200° F. (= 65·5° to 93·3° C.) for some weeks without combustion, torrefaction, or any change approaching either condition. In the patent dessicating process for timber, joists and beams are exposed for many days to temperatures of 200° to 300° F. [= 93·3° to 148·8° C.] in heated air without combustion. The most inflammable deal may be plunged into melted lead at 620° F., and zinc at 770° F., and retained there without igniting. [These temperatures equal 326·6° and 382·2° C.] The wood is simply charred when it touches the molten metal, but does not burn. The dried wood is in a condition to burn fiercely, but not to ignite spontaneously ; or no dwelling-house, locomotive, or steam vessel, would be safe for a single day." See also a paper by Chevallier, in the "Annales d'Hygiène," 1843, 1, p. 99, for instances of supposed spontaneous combustion, in which the ignition of combustible substances was caused by the friction of wheels or machinery. Many fires in houses, churches, workshops, &c., are due to the faulty construction of flues and chimneys, or to stove-pipes being so fixed as to heat woodwork.

Lampblack, and other similar things, such as charcoal finely divided, in bulk and perhaps mixed with a certain proportion of oily matter (hydrocarbon), appear prone to spontaneous combustion. See a case of fire on board a ship sailing from Portsmouth, containing *lampblack*, reported by Dr. Taylor (*loc. cit.*, p. 709) and Liebig's account of the phenomena in his "Organic Chemistry Applied," &c., p. 263. See also the "Annales d'Hygiène," 1841, 1, 343. In July, 1865, a fire, which occurred at Doncaster railway-station, was attributed to the spontaneous combustion of *lampblack*.

M. Aubert, a French engineer, ("Annales de Chimie," 1831) has found that charcoal free from oil, in a state of fine division, develops great heat, but it requires to be in masses of about sixty pounds ; and the greatest heat was in the centre, or about five or six inches below the surface.

Dr. Taylor gives an account (p. 710, *loc. cit.*) of two trials as to ships said to have been fired by coals containing iron pyrites. *Mitchell* v. *Gillespie*, C. P., 1856, is one of these. The other occurred in 1859.

Dr. Frankland showed, in the "Chemical News," 1862 [vol. vi., p. 3], that a full red-heat, visible in daylight (1160° F., or 626·6° C.) is required for the ignition of the gases derived from coal.

The *pyrites*, which most readily undergo this change, are those containing the protosulphide combined with the bisulphide of iron [Dumas'

"Traité de Chimie," vol. iii., p. 59]. Bisulphide of carbon is said to fire as low as 300° F. (=148·8° C.). But coal-gas, the vapours of alcohol, ether, oil of turpentine, and benzole, require a full red-heat, visible in daylight (1160° F., or 626·6° C.); but all these substances evolve vapours at lower temperatures, even below 100° F. (37·7° C.) or at little above blood-heat, and these may become accidentally kindled by contact with some heated or ignited body. *Phosphorus* (*see* page 68) has been known to melt, and fire spontaneously when touched in the air of a room whose temperature was about 70° F., or even less (=21·1° C.). At 120° F. (48·8° C.) it melts and burns readily. Dr. Taylor states that the ordinary lucifer-match composition fires at nearly the same temperature (120° F. or 48·8° C.). Hence large quantities of matches may fire in the summer, more especially as they become luminous in the dark in very hot weather. Red or allotropic phosphorus (used in wax matches, and now in most of the best kinds) requires a heat of 159° to 200° F. (or 70·5° to 93·3° C. to ignite it, even when mixed with chlorate or nitrate of potassium.

Cotton waste mixed with oil is known to be prone to fire. In 1865, at the Manchester Autumn Assizes, in *Knowles* v. *North British Insurance Company*, the verdict was returned in favour of the defendants, who alleged that plaintiffs had allowed cotton, lubricated with grease and oil, to be mixed with the ordinary cotton waste, hence causing the fire. Mr. Galletly ("Pharmaceutical Journal," September, 1872, p. 225) found this change rapidly produced when drying oils (linseed, &c.) were mixed with cotton waste ; with boiled linseed oil, less than two hours were required ; with raw oil, four to five hours only ; with rape oil, ten hours : with olive oil, five or six hours ; castor oil required two days ; lard oil, four hours ; sperm oil did not char the cotton waste, but *seal* oil produced ignition in 100 minutes.

Mr. Scanlan ("Records of Science," August, 1835) found that woody fibre impregnated with turpentine is liable to spontaneous ignition.

Dr. Taylor gives one or two instances of ships apparently lost from this cause.

We are led, from a comparison of these facts, to conclude that although human agency is often concerned, or the vapours of inflammable substances are brought into contact with fire or highly-heated bodies to produce the effect, *yet that undoubtedly spontaneous combustion is possible in a variety of substances from the mineral and vegetable kingdoms.* We will now come to the vexed question of

Spontaneous Combustion in the Human Body.

There is no subject in the whole range of Medical Jurisprudence on which so much romance has been built as upon this. Nearly all popular novelists and great writers have embellished their works by the introduction of some story of this kind, or amused themselves by telling or re-telling some of the current legends on this subject. The disappearance of the law-writer in Dickens's "Bleak House" is perhaps one of the best of these. Dickens, however, did more than merely use the incident. He thoroughly believed in the possibility of the occurrence. And in "All the Year Round" he collected a number of supposed authentic cases.

Different writers on Medical Jurisprudence have treated the matter from various points of view. Some, like Beck, just mention the subject, and give illustrative cases, scarcely expressing any opinion as to the possibility or otherwise of the event. Some, like Casper, contemptuously reject it; and offer as arguments against it, that a fœtus soaked a long time in spirits would not burn, and that the French are more credulous than the Germans. It is true that this author also quotes Liebig's statement as to the human body containing some 75 per cent. of water. Others, as Taylor, combat the theory of spontaneous combustion in a more scientific spirit. On a careful consideration of the whole case, we have come to the conclusion that *there is no authentic case on record, or at least we can find none, in which truly "spontaneous" combustion of the human body has occurred;* but that there is a certain amount of evidence to show that the bodies of habitual drunkards are more than ordinarily inflammable, and hence that slight accidents, such as the upsetting of a candle, or a spark from the fire, may probably lead to such combustion. It has been suggested that phosphuretted hydrogen may be generated in the human body, and Professor Apjohn appears to have favoured this view. The gases found in dead bodies are sometimes inflammable, as was the case with the gas in the peritoneal cavity of a typhus patient dissected by Dr. Balby ("Edinburgh Med. and Surgical Journal," vol. xxxvi. p. 221). And we know also that sulphuretted hydrogen, carbon monoxide, and light and heavy carburetted hydrogen, all of which are sometimes generated in the living body, are combustible gases. There remains, however, a question, whether they are likely to be present in quantity sufficient to burn the rest of the body to any extent. The subject of *Cremation* has lately excited considerable interest, and it would appear, as the result of the experiments made in this direction, that *nearly two hours are usually required to reduce the human body entirely to ashes, even with a very intense heat.* It is of course possible that an extremely intense heat might produce a similar effect in less time.

Should such a question as this—of the spontaneous combustibility of the human body—be submitted to you as a general question, you can, we think, only answer it with reserve as we have done. But in any given case of a body found burnt it is clearly your duty to carefully investigate the circumstances, and to endeavour to find some cause for the combustion. Of the various cases of alleged spontaneous combustion recorded by different writers, [of which Beck gives a large number, with references to more, and to various writers on the subject], we shall quote enough to show the nature of the evidence :—

One of the earliest *medico-legal* cases is related by Le Cat. The wife of the *Sieur Millet* of Rheims was drunk every day of her life. The domestic economy of the house was managed by a handsome young female. On the 20th February, 1725, *the wife was found consumed at the distance of a foot and a half from the kitchen hearth.* A part of the head, a few of the vertebræ, and a portion of the lower extremities were all that remained unconsumed. A foot and a half of the flooring under the body was burnt, but a wooden kneading trough and a tub which were very near the body, had sustained no injury. M. Chretien, a surgeon, examined the remains of the body with every juridical formality. *Jean Millet*, the husband, being interrogated by the judges, declared that about 8 p.m. on the 19th of February, he had retired to rest with his wife, who, not being able to sleep, had gone into the kitchen, where he thought that she was warming herself; that having fallen asleep, he was roused by an infectious odour; and that having run to the kitchen, he found the remains of his wife in the state described by the medical reports. The judges formed an opinion that he had conspired with his servant to destroy the wife, and he was condemned to death. On appeal, however, to a higher court, this decree was reversed, and it was pronounced a case of spontaneous combustion; but his health and fortune were irreparably destroyed, and he died in a hospital. Here it will be seen there were grave elements of suspicion, but even admitting the husband's statement, there is yet a great improbability that the combustion was spontaneous, as the wretched woman was so close to the fire. [Pierre Aimé Lair, in "Coxe's Emporium of Arts and Sciences," vol. i., p. 167, quoted by Beck.]

Beck quotes from the "Transactions of the Copenhagen Society," that, "in 1692, a woman of the lower class who had taken little but intoxicating liquors for three years, *sat down one evening in a straw chair to sleep;* and was consumed in the night-time, so that next morning no part of her was found except the skull, and the extreme joints of her fingers; all the rest of her body was said to be reduced to ashes. Again, the Countess *Cornelia Bandi*, of Cesena, in Italy, aged sixty-two, *who was accustomed to bathe all her body in camphorated spirits of wine*, fell asleep one evening, her maid remaining in the room until her mistress slept. When the girl returned in the morning she found nothing but the remains of the body in the most horrible condition. Four feet from the bed was a heap of ashes, in which the legs and arms were alone untouched; between the legs lay the head; the brain, together with half the posterior part of the skull, and the whole chin had been consumed; three fingers were found in the state of a coal, and the rest of the body was reduced to ashes, which, when touched, left on the fingers a fat, fœtid moisture. *A small lamp on the floor was covered with ashes, and contained no oil;* the tallow of two candles was melted on a table, but the wicks still remained, and the feet of the candlesticks were covered with moisture. *The state of the bedding suggested that she had got out of bed.* It was not damaged, though the furniture and tapestry were covered with a moist kind of soot of the colour of ashes, which had penetrated into the drawers and dirtied the linen." [Bianchini, quoted by Beck. *See* also Lair, and the "Philosoph. Trans.," vol. xliii., p. 447.]

In the "Philosoph. Trans.," vol. xliii., p. 463, it is recorded that "Grace Pett, the wife of a fishmonger, of St. Clement's, Ipswich, *used to go downstairs every night half-dressed, to smoke a pipe.* On the 9th of April, 1744, she got up from bed as usual. Her daughter, who slept with her, did not perceive that her mother was absent till next morning when she awoke. Soon after this she put on her clothes, and, going down into the kitchen, found her mother stretched out on her right side, with her head near the grate. The body was extended on the hearth, with the legs on the deal floor, and it had the appearance of a log of wood consumed by a fire without apparent flame. On beholding the spectacle, the girl ran in great haste and poured some water over her mother's body, to extinguish the fire. The fœtid odour and smoke which exhaled from the body almost suffocated some of the neighbours who had hastened to the girl's assistance. The trunk was in some measure incinerated, and resembled a heap of coals covered with white ashes. The head, the arms, the legs, and the thighs had also participated in the burning. *This woman,* it is said, *had drank a large quantity of spirituous liquor,* in consequence of being overjoyed to hear that one of her daughters had returned from Gibraltar. There was no fire in the grate, and the candle had burnt entirely out in the socket of the candlestick, which was close to her. There were also found near the consumed body, the clothes of a child, and a paper screen, which had sustained no injury. Her dress consisted of a cotton gown."

Another of Le Cat's cases quoted by Beck, was given him by M. Boinneau, curé of Plurguer, near Dol. It occurred in 1749. "Madame de Boiseon, aged eighty, a *great spirit drinker for many years, was sitting in her elbow chair before the fire,* while her waiting-maid went out of the room for a few moments. The maid on her return, seeing her mistress on fire, immediately gave an alarm, and some persons having come to her aid one of them tried to extinguish the flames with his hand, but they adhered to it, as if it had been dipped in brandy, or oil on fire. Water was brought and thrown on her, yet the fire appeared more violent, and was not extinguished till the whole flesh had been consumed. Her skeleton, exceedingly black, remained entire in the chair, which was only a little scorched; one leg only and the two hands detached themselves from the rest of the bones. *It is not known whether her clothes had caught fire by approaching the grate;* but she was in the same place in which she sat every day, there was no extraordinary fire, and she had not fallen."

The case of the priest *Bertholi*, in 1776, in Italy, quoted by Foderé, vol. iii., p. 210; "London Medical Repository," vol. i., p. 332; and given by Beck in foot-notes, is also extremely curious. "He had retired to a room in his brother-in-law's house, as was supposed, to pray. In a few minutes his cries caused the room to be entered. *He was found extended on the floor, and surrounded by a light flame, which receded as they approached, and finally vanished.* On the next morning, M. Battaglia was called, and examined the patient. He found the integuments of the right arm almost entirely detached from the flesh, and between the shoulders and thighs the integuments were injured. There was a mortification of the right hand, and this, in spite of scarification, rapidly extended itself. The patient complained of burning thirst, and was horribly convulsed; he passed by stool putrid bilious matter, and was exhausted with continual vomiting, accompanied with fever and delirium. On the fourth day, after two hours' comatose insensibility, he expired; and a short time previous to his death, M. Battaglia observed with astonishment, that the body exhaled a most insufferable odour—worms crawled from it on the bed, and the nails had become detached from the left hand. The account of the patient was, that he felt a stroke like the blow of a cudgel on the right hand, and at the same time saw a bluish flame attack his shirt, which was immediately reduced to ashes, the wristbands in the meanwhile remained totally untouched. A handkerchief between the shoulders and shirt was entire and free from any trace of burning. His breeches were also uninjured, but though not a hair of his head was burnt, yet his cap was entirely consumed. There had been no fire in the room except that the lamp, which had been full of oil, was now dry, and its wick reduced to a cinder." The vagaries of this fire are more like the effects of *lightning* [*see* page 966] than anything else. A case which is said to have occurred in the neighbourhood of Bordeaux in September, 1822, is too absurd to require either quotation or refutation.

The curious may find it in a foot-note to page 528 of Beck's work. Beck gives a number of references to articles on the subject, and to recorded cases in his foot-notes. The deductions of Drs. Lair and Marc, apply to most of these. They say:—1. Most of the sufferers were females and advanced in life. 2. Most of them were addicted to spirits, and were either very *fat*, or very *lean*. 3. The combustion occurred accidentally, and often from a very slight cause, such as a candle, a coal, or even a spark. 4. The combustion was very rapid, usually consuming the entire trunk, whilst the extremities, as the feet and hands, were sometimes left unhurt. 5. Water sometimes aided, rather than checked, the combustion. 6. The fire seldom did much other damage, and often did not affect the combustible objects which were in contact with the human body at the moment it was burning. 7. The combustion of these bodies left, as a residuum, fat, fœtid ashes, with an unctuous, stinking, and very penetrating soot. 8. These combustions have occurred in all countries and in all seasons.

Dr. Taylor (*loc. cit.*, p. 701) gives the case of a woman addicted to habits of intoxication, who was found dead in her room in December, 1864. Her clothes were on fire, and a chair had been burnt. The room when entered was filled with a thick, black, offensive smoke. On examination some of the bones were found quite bare of flesh. *A candle was still burning on the table*, and there was also a fire in the room. But otherwise the case (as Dr. Taylor says) might, from the peculiar features, have been taken for one of *spontaneous* combustion. So, he says, might the case of *Mrs. Pulley*, whose body was examined by the late Mr. Jackson, of Stamford, in 1860. The circumstances required little ingenuity to transform them into a case of spontaneous combustion, instead of, as it really was, *an attempt to conceal murder by strangulation.* There had been no fire in the grate. The deceased was lying on the hearth of her room, three or four feet from the grate. From the shoulders downward the body lay on a boarded floor of oak. She was fully dressed, and parts of her clothing and body had been destroyed by fire. *A brass candlestick was lying between the left arm and the body*, the top of the candlestick being inclined towards it. Her clothes were wholly burnt off both arms, and partly off the upper portion of the trunk. The legs were not at all burnt. A bonnet worn by her was partly burnt. The right arm was raised by the side, with the elbow resting on the floor. The fingers were partly burnt off, and the remainder of the hand was charred. Her left hand (which was stretched out) was less burnt than the right. Some ashes from the clothing lay between the left arm and the body. The fire was extinguished, but there was a strong smell of burning when the room was entered. Under the body there was a hole burnt in the oak floor. Her features were distorted and swollen, and the eyes suffused with blood. Some parts were burnt to a cinder, others were but little affected by the fire.

On the 6th of January, 1847, a man, aged seventy-one, was found by a grandson lying in bed in a state of combustion. The chamber was filled with dense smoke, and one witness asserted that he saw a small whitish flame playing around the body of the deceased, which receded as the witness approached. The clothes and bedcoverings were almost entirely consumed, but not the wooden bedstead. Very little of the body was left. *He usually carried lucifer matches in his waistcoat-pocket, and a hot brick was placed at his feet* *when he went to bed.* The son and his wife were suspected of having murdered him, and Dr. Masson was commissioned to examine the exhumed body, and both he and Orfila are said to have argued that it was a case of spontaneous combustion! ("Gazette Médicale," Sept. 4, 1847, and Taylor, *loc. cit.*, pp. 702-3. The same theory found favour in the case of the *Countess of Goerlitz*, for whose murder *John Stauff* was tried at Darmstadt, in March and April, 1850. This case has been mentioned at page 948, and is pretty fully reported in Dr. Taylor's book. The subsequent confession of the murderer absolves us from quoting it at length. One of the most recent cases is that of a woman *much given to drinking absinthe and other spirits* to excess. "On the 1st of August, 1869, having drank largely, she went to her bedroom about 5 p.m. Two hours after, her husband trying to enter, found the door very hot. He raised an alarm of fire, and the room was entered by the window. There was a nauseous odour, and a sense of suffocation on entering. The dead body of the woman was found on the floor between the bed and the hearth—the head being partly under the bed, and the legs across the hearth. There was no fire in the grate, and the trap was down. The floor on which the body lay was more carbonized than burnt, on it were found fragments of bones, some of the ribs, a hand, and some ashes. The head, which was swollen and livid (violet-red) presented no mark of burning. The hair, even, was not burnt, any more than the upper part of the trunk, which was covered with a black powder from the burnt clothes. The left arm was wanting from the shoulder. The right arm had lost the hand, which was disarticulated at the wrist. The elbow joint was exposed, but the muscles of the arms were not destroyed. The left side and front of the chest were widely open, but there was no trace of the viscera of the thorax. The lower ribs were separated. The walls of the abdomen were gone, and its cavity empty, the viscera being reduced to a greasy black soot, adhering to the vertebræ. The bones of the spine and pelvis remained, but the muscles and fasciæ had disappeared. The lower limbs, from the thighs downwards, were entire, the skin being covered with a black powder; but there were no blisters on these parts. It was further stated that although there was no apparent source of fire or ignition in the room, and the bed and its furniture had escaped burning, the floor was still burning, but without flame [smouldering], when the room was entered. Neither candle, match, nor fuel was found near the body. No noise or cry of alarm was heard, and the opposite neighbours saw no signs of fire to attract their attention to the chamber. [*See* Reports of Drs. Bertholle and Strohl in "L'Union Médicale," November 19, 1870, and the "Ann. d'Hygiène," 1871, 1, 228; and Taylor, *loc. cit.*, p. 705.] Dr. Taylor suggests, with great perspicacity, that the wretched woman in all probability had matches about her person. As regards the dark greasy or sooty matter, and the empyreumatic odour, he refers to Tardieu's paper in the "Annales d'Hygiène," 1850, 2, 191, and 363, and for 1851, 1, 99; and also to a paper by Dr. Ogston in the "Medical Gazette," vol. xlvi., pp. 889 and 948. He gives a curious case in which a dead body was found thirteen months after death almost entirely consumed along with the coffin. It appears that a bad smell attracted attention to the vault, which was opened; the coffins (one of which was metal) had burst, and therefore the body was placed with sawdust in the coffin, the gas turned off, and all, as was thought, left safe. But in the morning the vault was found on fire, with the result above mentioned (Taylor, *loc. cit.*, p. 706). Mr. Worthington, of Garston, near Liverpool, who consulted Dr. Taylor on the case, discovered that one of the workmen was smoking in the vault the night before, and as there were gas-pipes, it is by no means certain that the burning was due entirely to the gases from the body. No doubt the sawdust acted as fuel.

In the case of *Regina* v. *Hatto* (Aylesbury Lent Assizes, 1854), in which Dr. Taylor was consulted, a woman was found dead in her room, much burnt, and was known to have been alive about 8.15 p.m., whilst her body was found still smouldering at 11.15 p.m. (or three hours after). Her clothes were much burnt. But the most important part in this case, as it appears to us, is, that Dr. Taylor found that *a hempen mat under the body was so saturated with melted human fat that it burned like a link* when he ignited it. The subsequent confession of the prisoner showed that the burning of the body must have taken place in less than two hours, and might have done so in about an hour and a half. "Both knees," said the surgeon, "were consumed by fire, and the thighs, as well as the private parts were burnt to a cinder, leaving the shafts of the thigh bones exposed and charred for several inches. Between the thighs and the feet the floor underneath had been burnt away, and the leg-bones had fallen through the floor, leaving the feet, unburnt, upon the floor." Her clothes were much burnt.

Here we must conclude our quotations, reminding you again that we cannot find any proofs of truly *spontaneous* combustion in the human subject, but we do find a considerable number of cases in which old, infirm persons, mostly spirit-drinkers, met their death by fire, originating, as it would appear, in an accidental spark, or in their clothes catching fire. In many of these cases the combustion of the body was far more perfect than that of the clothes, or of surrounding and often inflammable substances. There appears, therefore, a strong probability that the bodies of spirit-drinkers are more combustible and more easily set on fire than those of persons not addicted to such drinks.

But most of the recorded cases are marred by a want of precision in details, or by an evident credulity on the part of those who relate them. And not a few, as we have shown, of the supposed cases of spontaneous combustion turn out to be murders, in which the culprits hoped to conceal the traces of their crime by fire. Experiments on the combustibility of animal bodies would appear to be still wanting to give definiteness to our notions on these points.

STARVATION; DEATH FROM INSUFFICIENT NOURISHMENT; CASES OF REAL AND PRETENDED FASTING.

Your opinion may be requested on the following cases:—

1. Parents, guardians, or employers, may be charged with giving their children, relations, pupils, servants, or apprentices insufficient nourishment, and thus causing either death, or danger of death to the victims.

2. You may be asked what quantity of nourishment is required to maintain health (in the cases of children and young persons in schools, workhouses, and reformatories, or of older persons in gaols, barracks, camps, workhouses, and similiar institutions).

3. Real or pretended cases of prolonged fasting may be submitted to

you for your opinion, or the conduct of persons concerned in such cases as that of the *Welsh fasting girl*, may be called in question, and your opinion asked. In order to guide your opinion we must commence with—

Some general Observations on Food.

The language of Holy Writ, that "Man cannot live by bread alone," is, strictly and literally, true. Variety of food is an absolute essential to health, and the only food which by itself is capable of sustaining life for an indefinite period, and building up the tissues, is *Milk*—which has often been called a perfect type of what food ought to be, and is, in truth, a highly complex fluid.

Its composition, in different mammals, is thus given in Carpenter's "Physiology:"—

	Woman	Cow	Goat	Sheep	Ass	Mare
	(Simon).	(Simon).	(Chevallier).		(Simon).	(Luiscius).
Water	890	860	868	856	907	888
Solids	110	140	132	144	93	112
	1000	1000	1000	1000	1000	1000
Butter	25	38	33	42	12	8
Casein	35	68	40	45	16	16
Sugar and extractives	48	30	53	50	65	88
Fixed salts . . .	2	6	6	7		

If we analyse this constitution of milk, we find the following kinds of nutritious material:—

1. A large proportion of *water*, amounting in the milk of all these animals to some 80 to 90 per cent. Experience shows that for an adult some two to three pints of liquid of some kind (of which the essential ingredient is water) are required for health, *per diem* (of twenty-four hours). From one to two pints of liquid are required by young infants. Growing children, between twelve months of age and puberty, both take and require a larger amount of fluid than most physiologists are aware of, or would admit.

This may be called *aqueous* food. As before said, some 72 to 75 per cent. of the human body is composed of water.

2. Of *fatty*, or *oleaginous matter*, which is called *butter* in milk; the amount is greater in cow's milk than in woman's. Fatty food, or *oleaginous* food, is absolutely necessary for the maintenance of animal heat, and the growth and repair of nervous tissues, and perhaps for other purposes. The inhabitants of cold countries appear to be able to assimilate more fat, and perhaps to require it, than those of temperate or tropical regions. Hence the stories of Esquimaux and Greenlanders consuming candles, and similar luxuries. The value of cod-liver oil in pulmonary phthisis, and other wasting diseases, is well known. A lady has informed the Authors that a few years ago a troublesome outbreak of skin-disease (somewhat allied to eczema, but of dartrous nature), in the Haverfordwest workhouse, was quickly cured by a more liberal allowance of butter being given to the pauper children, who before had scarcely any. If butter, on account of cost, is sup-

pressed, or sparingly given, dripping, or some other kind of animal fat, ought to be substituted.

3rd. The *casein of the milk* represents what are called the *albuminous* or *nitrogenous* constituents of food. The *gluten* of bread, the *legumin* of peas, beans, and other legumes, the *albumen* of eggs, the *syntonin*, and *myosin* of the red meat or muscle of animal food, and the *gelatin* of bones, ligaments, tendons, &c., are all of very similar constitution. Pure albumen dried at 212° F. (100° C.) contains carbon 53·5, hydrogen 7, nitrogen 15·5, oxygen 22·4, sulphur 1·6, and phosphorus about 0·4 in 100 parts.

It has been found that health cannot long be maintained on pure albumen, of which also the appetite soon cloys and sickens. Yet, undoubtedly, the albuminous foods are extremely necessary for tissue-building, and for the repair of muscular waste.

4th. We have *saccharine and extractive matter* in milk, which answers to the *saccharine* and *starchy* constituents of bread, and other vegetable foods. Starch being called *amylum* in Latin, has given the name of *amylaceous* to this kind of food. Many medical men use the term *farinaceous*, as if it were an equivalent term to amylaceous or starchy. This is not so. *Farinaceous* food contains some gluten, legumin, or other form of vegetable *albumen*, and the name signifies that it is like *farina* or flour (mealy). Arrowroot is a purely starchy or amylaceous food, so is sago, tapioca, &c., whilst wheat-flour, the flour of Indian corn (maize), and of barley, oats, millet, lentils, beans, peas, &c., are farinaceous food.

5th. Lastly, we have *mineral* constituents in both milk and other foods. Chlorides of sodium, potassium, calcium, and magnesium, phosphates of these and of other metals, carbonates of the alkaline and earthy metals, and salts of iron, and perhaps manganese, are the most important of these. Criminals were at one time deprived of salt in Holland, and are said to have perished miserably. It is quite certain that all the salts named are necessary to make up the blood and tissues.

Food has been classed in other ways, as for example:—*Nitrogenous*, histogenetic (or tissue-forming food, of which casein, and the different kinds of albumen, animal and vegetable, are types: and *non-nitrogenous*, *carbonaceous*, or respiratory food, which includes the saccharine, amylaceous or starchy, oleaginous, mineral, and aqueous varieties of food. These names, however, involve theories, which are by no means proved, and are very difficult to prove.

Nearly all known articles of diet, except pure starches, sugar, and some fats, are more or less mixed in their composition, and, as we have shown above, such mixture is essential to health.

We do, however, know that an average adult daily loses about 4,501 to 4,600 grains of carbon, and about 300 of nitrogen, or very near 11 ounces of solids, which are thus disposed of as excreta: *

By the lungs	about	32	per cent.
,, ,, skin	,,	17	,,
,, ,, fæces	,,	$4\frac{1}{2}$	,,
,, ,, urine	,,	$46\frac{1}{2}$	,,

If a man were to live only on albuminous articles of food, as the proportion of carbon in these is about 3·5 to 1, he would be taking about fifteen times as much nitrogen as he wants, in order to get enough carbon. Hence the use of other articles of food, of the amylaceous or starchy kinds, as diluents.

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* See Payen, "Des Substances Alimentaires." Paris, 1854.

Again, as the proportion of carbon to nitrogen in bread is about 30 to 1, if a man eats enough bread to give him all the nitrogen he wants, he will take about twice as much carbon as he really wants. Or, to put the matter in a very practical shape, if the man is to live on butcher's meat alone, he would want 45,000 grains, or nearly 6½ pounds containing—

Carbon	4,500 grains.
Nitrogen	1,830 „

Excess of nitrogen above that required, 1,500 grains. Or, on a bread diet, some 30,000 grains, or nearly 4¼ pounds, containing—

Carbon	9,000 grains.
Nitrogen	300 „
Excess of carbon above the amount required	4,500 „

But a combination of bread and meat would far more economically supply his wants.

	Carbon.	Nitrogen.
Thus 15,000 grains of bread (or rather more than two pounds) contain	4,500 grs.	150 grs.
5000 grains of meat (or about ¾ pound) contain	500 „	150 „
	5,000	300

This is almost the same estimate as that given by Béclard in his "Traité Elémentaire de Physiologie," p. 570, &c.

Here the waste is comparatively trifling.

In practice it is found that some people take rather more, and others rather less, than the amount calculated. This depends rather on habits of life and constitution than on mere body weight. For the experiments which have led to these conclusions, see Carpenter's "Physiology," 8th ed.; Kirke's "Physiology," or Dalton's, or any modern treatise on the same science.

In German, Funke's "Lehrbuch der Physiologie" deals very fully with this subject.

Growing children and young adults, those who lead an active life, pregnant women, and those much in the open air, require and take more food than older persons, or those of more sedentary habits. The absence of what some might consider luxuries, such as fresh vegetables and fruit, have over and over again led to outbreaks of scurvy, of which we shall speak again.

Special works on diet, such as those of Pereira, Letheby, and Pavy, give numerous diet tables, showing the nutrient value of various articles of diet. We are especially indebted to Letheby, Playfair, Frankland, and Parkes, in England, for careful summaries of this kind.

The following table shows what are called the *relative values* of foods of different kinds, calculated on human milk as a basis, which is taken at 100. In using such tables regard must be had to age, climate, and other circumstances of life, and to the individual power of digestion. You may say that raw beef is 880 times more nourishing than the same weight of human milk, but you must not say it is 880 times better as an article of diet for an infant of a few weeks or months, for that would be false.*

TABLE I.—*Relative Values of Various Articles of Food.*

Human Milk = 100.

Vegetable.

Rice	81	Barley	125	Brown Bread	166
Potatoes	84	Oats	138	Peas	239
Turnips	106	White Bread	142	Haricot Beans	283
Rye	106	Wheat	119—144	Agaricus deliciosus	289
Maize	100—125	Carrots	150	Beans	320

Animal.

Human Milk	100	Salmon, boiled	610	Flounder, boiled	954
Cow's ,,	237	Portable Soup	764	Pigeon, raw	756
Oysters	305	White of Egg	845	,, boiled	827
Yolk of Eggs	305	Crab, boiled	859	Lamb, raw	833
Cheese	331—447	Skate, raw	859	Mutton, raw	773
Eels, raw	434	,, boiled	956	,, boiled	852
Mussels, raw	528	Herring, raw	910	Veal, raw	873
Ox-Liver, raw	570	,, boiled	808	,, boiled	911
Pork-Ham, raw	539	Haddock, raw	920	Beef, raw	880
,, boiled	807	,, boiled	816	,, boiled	942
Salmon, raw	776	Flounder, raw	898	Ox Lung	931

This is one of the older tables, but it does not materially differ from some more recent ones. Take, for example, that given by Dr. Parkes, as used at Netley :—

TABLE II.—*Nutritive Value of Foods in* 100 *parts.*

Substance.	Water.	Nitrogenous Substances.	Fat.	Carbohydrates, Starch, and Sugar.
Meat without Bone	74	16	9	0
Fat of Meat	63	14	14	—
Bread of average quality (white wheaten)	40	8	1·4	51
Starch	0	0	0	100
Fat	—	—	100 =	240 Starch
Peas	15	24·4	2·6	49
Potatoes	74	1·5	0·6	29
Rice	10	3·8	0·8	85·2
Milk (Cow's)	87	4·3	3·7	5·2
Maize (after Poggiale)	13·5	9·9	6·7	64·5
,, (after Von Bibra)	10·6	15·09	3·8	67·46

The next table, from Dr. Letheby, is one of great value :—

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* For special information as to the diet and regimen proper in particular diseases and individual cases, the following English works may be consulted with advantage and profit, besides the general manuals quoted on the preceding page :—

Chambers, (Dr. T. King) : "A Manual of Diet and Regimen in Health and Disease" (1876). *Dobell* (Dr. Horace B.) : "On Diet and Regimen in Sickness and Health, and on the Inter-dependence and Prevention of Diseases, and the Diminution of their Fatality," (1865). *Pavy* (Dr. Frederick William) : "A Treatise on Food and Dietetics, Physiologically and Therapeutically considered," (1875).

TABLE III.—*Nutritive Value of Foods.*

[In this table carboniferous matter is calculated as starch, ten of fat being equal to twenty-four of starch.]

SUBSTANCES. (100 parts.)	Water.	Fibrine, Albumen, &c.	Starch, Sugar, &c.	Fat.	Salts.	Carboniferous.	Nitrogenous.	Total Nutriment.
Human Milk	89	3·5	4·2	3·0	0·2	11·4	3·5	14·9
Cow's Milk	86	4·5	5·0	4·1	0·7	14·8	4·5	19·3
Skimmed Milk	87	4.5	5·0	2·7	0·7	11·5	4·5	16·0
Butter Milk	87	4·5	5·0	0·5	0·7	6·0	4·5	10·5
Beef and Mutton	73	19·0	—	5·0	2·0	12·0	19·0	31·0
Veal	77	19·0	—	1·0	0·6	2·4	19·0	21·4
Poultry	74	21·0	—	3·0	1·2	7·2	21·0	28·2
Bacon (fat)	20	·8	—	70·0	1·3	168·0	0·8	168·8
Cheese (Cheddar)	36	29·0	—	30·0	4·5	72·0	29·0	101·0
„ (skimmed)	44	45·0	—	6·0	5·0	14·4	45·0	69·4
Butter	15	—	—	83·0	2·0	199·0	—	199·0
Eggs	74	14·0	—	10·5	1·5	25·0	14·0	39·0
White of Egg	78	20·0	—	—	1·6	—	20·0	20·0
Yelk of „	52	16·0	—	30·0	1·3	72·0	16·0	88·0
White Fish	79	19·0	—	1·0	1·2	2·4	19·0	21·4
Salmon	78	17·0	—	4·0	1·4	9·6	17·0	26·6
Eel	80	10·0	—	8·0	1·3	19·2	10·0	29·2
Wheat Flour	15	11·0	70·0	2·0	1·7	74·8	11·0	85·8
Barley Meal	15	10·0	70·0	2·4	2·0	75·8	10·0	85·8
Oat Meal	15	12·0	62·0	6·0	3·0	76·4	12·0	88·4
Rye Meal	15	9·0	66·0	2·0	1·8	70·8	9·0	79·8
Indian Meal (Maize)	14	9·0	65·0	8·0	1·7	84·2	9·0	93·2
Rice	14	7·0	76·0	0·3	0·3	76·7	7·0	83·7
Haricot	19	23·0	45·0	3·0	3·6	52·2	23·0	75·2
Peas	13	22·0	58·0	2·0	3·0	62·8	22·0	84·8
Beans	14	24·0	44·0	1·4	3·6	47·4	24·0	71·4
Lentils	14	29·0	44·0	1·5	2·3	47·6	29·0	76·6
Wheat Bread	44	9·0	49·0	1·0	2·3	51·4	9·0	60·4
Rye Bread	48	5·0	46·0	1·0	1·4	48·4	5·3	53·7
Potatoes	74	2·0	23·0	0·2	0·7	23·5	2·0	25·5
Green Vegetables	86	2·0	4·0	0·5	0·7	5·0	2·0	7·0
Arrow Root	18	—	82·0	—	—	82·0	—	82·0

A similar table from Budge and Moleschott will be found at p. 77 of Carpenter's "Physiology," 7th edition. Although somewhat more pretentious and learned-looking, it is not so handy for use, and does not differ essentially from the one given above.

You may be asked, "How much food ought a healthy man to consume daily?"

We have already given you the elements of calculation for this, intended for a man of about nine or ten stone [126 to 140 pounds]—viz., that about two pounds of bread, and three-quarters of a pound of meat will be sufficient for him, along with from one and a half to three pints of fluid. You will find that authors differ somewhat in their estimates. Thus Dr. Dalton ["Physiology," 1871, p. 101] states that rather less than two and a half pounds of solid food, and rather over three pints of liquid food are required by a man in full health, and taking free exercise, which he apportions as follows:—

Meat	16 oz.	or 1·00lbs.	avoirdupois
Bread	19 oz.	or 1·19 „	„
Butter or fat	3½ oz.	or 0·22 „	„
Water	52 fluid oz.	or 3·38 „	„

Vierordt ["Grundrisz der Phys.," 1860, p. 192] considers the adult to be well nourished, if with moderate exercise, he receives daily about 4 ounces of dry albumen, 3 ounces of fat, 11½ ounces of some starchy substance, and about 1 ounce of salt, which gives a proportion of one part of nitrogenous to 3½ parts of non-nitrogenous food. If to this about 6 pints of water, and the oxygen taken up in the act of respiration, which he estimates at 1½lbs., be added, we shall obtain a total of about one-twentieth of the weight of the body, consumed in twenty-fours-hours. But this quantity is probably insufficient, at least for active exercise.

Our best experience is gained from large bodies of men, and from public institutions. In the British Navy the men get 31 to 35½ ounces of *dry* nutritious material daily; of this 26 ounces are vegetable and the rest animal; and, like the diet of the British soldier, contain 5 ounces of nitrogen compounds and 10 ounces of carbon. The Dutch soldier, in war time gets 5 oz. of nitrogen compounds to 10½ ounces of carbon ones, but in peace only 3½ ounces of the former. The French soldier 4¾ ounces and 12 ounces respectively; Greenwich pensioners, 3½ ounces and 10 ounces; the old men of Gillespie's Hospital, Edinburgh, 3 ounces and 10 ounces. The average of all the workhouses in the kingdom gives 3⅐ ounces of nitrogenous food, and 8¼ ounces of carbon, for each pauper. This is, however, somewhat under the mark. The boys of the Royal Naval School at Greenwich get 2½ ounces and 7½ ounces; whilst those of Christ's Hospital in London have only 2½ ounces of nitrogenous food, and 7 ounces of carbonaceous, for their diet. This is, however, largely supplemented by "hampers" from friends, and other extras.

In a well-managed school, where the average numbers are over 400, including both boys and girls, the children being received from nine to fourteen years, and presenting a picture of health, the daily diet appears to consist of—

Bread from - - -	6 oz.	to	16 oz.,	according	to age.
Meat (cooked) - -	4 ,,	to	6 ,,	,,	,,
Butter or cheese - -	½ ,,	to	1 ,,	,,	,,
Vegetables (chiefly potatoes)	4 ,,	to	8 ,,	,,	,,
Milk - - - -	15 fluid ounces.				

A part of the latter is used in puddings.

This will give about 12¼ ounces of carbon compounds and about 2¾ of nitrogen ditto.

Table No. V. gives some other diets.

The following table is given by Dr. Edward Smith.

TABLE NO. IV.

	Daily excretion of carbon.	Daily excretion of nitrogen.	Carbon required.	Nitrogen required.
Food of middle life, with no work	7·9 ounces.	260 grains	9½ to 10½ ounces.	200 grains = rather less than ½ an ounce.
Active middle class, and light labour in lower classes..........................	9·5 ,,	200 ,,		
Hard labour in lower classes	12·5 ,,	Not stated. 300 to 400 probably.	12½ to 14 ounces.	250 grains, or rather more than ½ an ounce.

These proportions, however, represent dry food. Infants are said to consume no less than 136 grains of carbon to each pound of body-weight, or from three to four times as much as an adult in proportion to weight; whilst the quantity of nitrogen consumed by the infant is about six times that of the adult per pound of body-weight. Similarly the adult excretes about 3 grains of *urea* [$\frac{28}{60}$, or nearly half of which is nitrogen] per pound of body-weight, whilst the infant excretes about 5 grains per pound of body-weight. In other words, a man of 10 stone gets rid of about an ounce of urea in twenty-four hours, and an infant weighing 24 pounds only will get rid of about $\frac{1}{4}$ of an ounce of urea per diem. Dr. Edward Smith gives the following diet-scale for a man in good health, with good appetite and moderate exercise :—

Breakfast : $\frac{3}{4}$ pint of milk, $\frac{1}{4}$ pint of water with tea or coffee ; bread, 4 to 6 ounces ; butter, $\frac{3}{4}$ ounce ; sugar, $\frac{3}{4}$ ounce ; bacon, 3 ounces [or eggs, 4 ounces, 2 to 3 eggs], or cooked meat, 3 ounces. *Dinner* : Cooked meat, 4 to 6 ounces ; potatoes, 8 ounces ; bread, 3 ounces to 4 ounces ; pudding, 8 ounces ; cheese, $\frac{1}{2}$ ounce ; soup, 6 ounces ; water or beer, $\frac{1}{2}$ pint. *Tea* : Water with tea, $\frac{3}{4}$ pint ; sugar, $\frac{3}{4}$ ounce ; milk or cream, 2 ounces ; bread, 3 ounces ; butter, $\frac{1}{2}$ ounce to $\frac{3}{4}$ ounce. *Supper* : Milk, $\frac{3}{4}$ pint, oatmeal, 1 ounce ; and bread, 3 to 4 ounces ; or eggs, 4 ounces, or cooked meat, 3 ounces, and bread, 3 ounces ; butter or cheese, $\frac{1}{2}$ ounce ; water or beer, $\frac{1}{2}$ pint.

We may therefore safely say that in order to maintain health and vigour :

1st. Food must be sufficient in quantity, or from 25 to 30 grains of carbon for every pound of body-weight ; and from 1 to $1\frac{1}{2}$ grains of nitrogen for every pound of body-weight in adults, and more of both for infants (see above). You may be asked how much milk an infant, fed wholly (as young babies who have no teeth, or only one or two, should be) on milk, requires per diem :—

The answer will be from 1 to 3 pints * according to age.

2nd. The food should be of good quality. [*See* the next section on Ergotism, &c.].

3rd. It should be properly cooked. Underdone food may give worms. Over-cooked food is difficult to digest, unpalatable, and often proves injurious.

4th. There must be variety. [*See* the remarks on Scurvy and other diseases in next section.] Not only must there be sufficient carbon and nitrogen, but some 200 to 600 grains of mineral matters, and some 5 to 6 pints of water in all, or from 2 to 3 pints besides that contained in the articles of food, of which, as we have seen, some fifteen per cent., even of dry flour, and some 90 per cent. nearly of human milk are composed.

5th. The intervals of feeding must not be too long. Whilst the very young and new-born infant may require the breast every two hours or so, and older children require food about every three or four hours, during the daytime; few adults can dispense with three meals, and most do better with four meals per diem. Those who eat only once or twice a day as some savages do, and a few medical men (like the eccentric Dr. Mounsey) have done, are apt to overload the stomach when once they sit down to their meal.

6th. The food must be *digestible*. Although the "*dura ilia messorum*" may extract nutriment from the crudest of berries, the fattest of bacon, and the toughest of cheese; whilst salt junk as hard as a board may be digested by the stomachs of British sailors; the same food would probably mean starvation to the delicately-nurtured child or lady of the affluent classes, or to the literary man who takes but little exercise. As Dr. Dalton well says: "A vegetable or animal tissue may contain an abundance of albuminoid or starchy matter, but may be at the same time of such an unyielding consistency as to be insoluble in the digestive fluids, and therefore useless as an article of food. Bones and cartilages, and the fibres of yellow elastic tissue are indigestible and therefore not nutritious. The same remark may be made with regard to the substances contained in woody fibre, and the hard coverings and kernels of various fruits. Everything therefore which softens or disintegrates a hard alimentary substance renders it more digestible, and so far increases its value as an article of food ["Physiology" (1871), p. 100]. From 15 to 30 per cent. or about $\frac{1}{4}$th, on an average, of the weight is lost in most methods of cooking meat. Therefore 8 ounces of raw meat will about equal 6 ounces of cooked.

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* No very accurate estimates have been made of the quantity of milk secreted by human beings during lactation. Lamperriere obtained about one kilogramme of milk in twenty-four hours (equal to 35 ounces nearly), or about 22 grammes to each kilogramme of body weight. This agrees nearly with M. Guillot's estimate of 32 to 64 ounces, founded on the comparative weight of the infant, before and after lactation. *See* "L'Union Médicale," 1852 (No. 16).

TABLE V.—*From Dr. Letheby.*

Dietaries and their Nutritive Values.

DIETS.	WEEKLY CONSUMPTION (IN OUNCES).							DAILY DITTO.		
	Bread or Biscuit.	Meat.	Potatoes.	Meal, &c.	Milk.	Cheese.	Butter.	Carboniferous.	Nitrogenous.	Total Solid Nutriment.
Physiological	140	84	—	—	—	—	3·5	12·7	4·0	16·7
Prison Punishment	112	Will only sustain life for a limited period, when combined with water.						8·2	1·4	9·6
English County and Borough Gaols:—										
Under 7 days	121	—	—	23	39·5	—	—	12·4	2·2	14·6
Not hard labour	172	7·8	3·2	22·8	15·4	3·5	—	15·7	3·1	18·8
Hard labour	163	14·6	63·4	27·2	41·6	1·5	—	18·2	3·5	21·7
Scotch Prisons:—										
Under 3 days	112	—	—	—	—	—	—	11·2	1·9	13·1
Not hard labour	30	7·5	152	73	175	—	—	19·0	3·4	22·4
Hard labour	76	10	176	100	175	—	—	27·0	4·5	31·5
Irish Prisons:—										
Under 1 month	56	—	192	70	70	—	—	19·5	2·9	22·4
Not hard labour	56	—	192	60	170	—	—	20·5	3·4	23·9
Hard labour	64	—	219	70·5	170	—	—	22·0	3·6	25·6
Military Prisons:—										
Under 84 days	56	—	—	119	210	—	—	22·2	3·8	26·0
Over 84 ,,	56	—	—	168	210	—	—	27·8	4·7	32·5
Convict Prisons	161	36	112	12	12·8	—	—	18·4	3·6	22·0
Unions (adults)	112	15·5	51	17	34	5·2	1·1	14·2	2·8	17·0
,, (children)	90	14·0	32	—	105	—	3·5	11·1	2·3	13·4
Lunatic Asylums	114	23·0	68	16	14	7	1·3	13·2	4·0	17·2
Public Hospitals	93	52	56	14	7	—	3·2	12·1	3·5	15·6
Army (Crimea)	112†	112	—	—	—	—	—	14·5	4·8	19·3
,, (Home)	168	84	112	—	—	—	—	19·4	4·8	24·2
,, (in Madras)	112	112	56	4*	—	—	—	16·5	4·9	21·4
Navy	112†	112	56	—	—	—	—	17·7	5·0	22·7
Navvy (in the Crimea)	140‡	140	—	28	—	—	—	17·8	6·2	24·0
,, or Navigator (Home)	320‡	96	64	—	—	12	4·0	18·6	7·7	26·3
Yorkshire Labourer	280	126	28	—	210	—	49	42·2	8·8	51·0
Berwickshire ,,	122	—	—	224	224	—	—	37·1	7·0	44·1

In this table only the most important articles of diet are mentioned, although the other, excepting beer, spirits, tea, and coffee, are calculated in the daily consumption: * are rations of rice, and † of biscuit. Gruel is calculated at the rate of two ounces of meal per pint. ‡ "Navvy," another name for an excavator or railway labourer.

On the use of Tea, Coffee, Cocoa, and Alcoholic Liquors.

Although the exact value of none of these can be stated in so many words, yet there can be little reasonable doubt that all of them act more or less as food,—in other words, are digested and decomposed to a certain extent in the body, and help either to replace tissue, or to prevent its wear and tear.

Tea and coffee have a very similar composition, which is said to be as follows, in 100 parts :—

	Tea.	Coffee.
Water	5	12
Thein or Caffein	3	1·75
Casein	15	13
Gum	18	9
Sugar	3	6·5
Tannic Acid	26·25	4
Aromatic Oil	0·75	0·002
Fibre	20	35·048
Fat { Chlorophyl Wax Resin	4	Oil and Palmitin } 12
Mineral substances	5	6·7

In making tea or coffee, the casein is not generally dissolved unless a little soda be added to the water. The alkaloid *thein* is almost identical with that found in Maté or Paraguay tea, in Gurana, and in erythroxylon coca, and other plants. Its composition is said to be $C_8 H_{10} N_4 O_2$. Theobromine ($C_7 H_8 N_4 O_2$) is of very similar nature, but is found in cocoa and chocolate. Their restorative properties are well known. They are slightly nutrient, and are believed by some to lessen the excretion of urea, and the disintegration of muscular tissues.

The common constituent of all the so-called intoxicating or alcoholic liquors is *alcohol*, which exists in varying proportions. Beer and Porter generally contain from 4 to 12 per cent. The light wines of France and Germany 12 to 20 per cent. Sherries and Ports more than this—from 19 to 25 per cent.

The following, according to Mr. Brande, are the average quantities of alcohol, sp. gr. 0·825 at 60° F., in some kinds of ardent spirits.

100 parts (by measure) of	Alcohol (by measure).
Brandy contain	55·39
Rum ,,	53·68
Gin ,,	51·60
Scotch Whisky contain	54·32
Irish do. ,,	53·90

Or in common language they may be said to be about half alcohol and half water. Absolute alcohol has a sp. gr. of only 0·7938 at 60° F. (15·5° C.). In other words the gallon weighs less than eight pounds, whereas a gallon of water contains ten pounds weight. In trials *involving habits* *of intemperance* it sometimes becomes a question of how much beer or wine is equal in strength to so much spirit. So far as the percentage of alcohol is concerned, the above data will enable you to state that—

One "glass" of spirits is about equal to
  Four or five wine glasses of port or sherry, or
  Seven or eight ditto of light wine, or
  Two or three tumblers of ale or stout.

But there are many other things which have to be taken into account in actual cases. Thus beer is often adulterated with Cocculus Indicus, the active principle of which (picrotoxin) has been described at pp. 361-2, &c. Wines contain peculiar ethers, and spirits are largely adulterated; whilst for want of careful rectification, common spirits often contain a large quantity of fusel oil or fousel oil [$C_5 H_{12} O$, *see* page 502]. A host of other substances are either used purposely to adulterate alcoholic liquors, or are accidentally present. Hence the effect of a particular liquor can scarcely be predicated, but must rather be the subject of experiment. Free carbonic acid appears to add to the intoxicating effects of weak alcoholic beverages. For this reason, champagne and other sparkling wines, though comparatively poor in alcohol, intoxicate quickly. Their effects are said to pass off with almost equal rapidity. The effects of excess in the use of alcohol have been briefly mentioned at page 498. The symptoms of acute poisoning are tolerably definite. Those of chronic alcoholism are less unequivocal, similar changes sometimes occurring from other causes. There is, however, a pretty general agreement amongst medical men that drunkards are specially prone to some one or more of the following diseases and degenerations:—

Degenerations of tissue common in Drunkards.

(1) Albumenoid [*synonyms*, amylaceous, lardaceous, or waxy] degenerations of the blood-vessels, liver, kidneys, spleen, &c.

(2) Fatty and fibroid degeneration of the same tissues and organs, involving also the brain, spinal cord and nerves.

(3) Calcareous or mineral degeneration of the blood-vessels, cartilages, tendons, ligaments, &c., &c., and of the tissues and organs named above.

It is doubtful whether cancerous degeneration is or is not favoured by such habits. It is said by some that both cancer and tubercle are held in check by the free use of ardent spirits.

Diseases to which Drunkards are specially prone.

Aneurisms, acne, albuminuria (and other forms of *Bright's Disease*), anasarca, anthrax (or *carbuncle*), apoplexy, arthritis, ascites and other forms of *dropsy;* bronchitis, chronic *disease of the brain and spinal cord* [including general paralysis, dementia, paraplegia, hemiplegia, want of co-ordination of muscles, chronic mania, melancholia, monomania, anaesthesia, &c., &c.,] calculous disorders, catarrh, cirrhosis of liver and lungs [= "gin-drinkers' liver," and "Corrigan's Phthisis;"] *delirium tremens* and other kinds of delirium, diabetes, dyspepsia, diarrhœa, and dysentery;

epilepsy, erysipelas, gangrene, gastric ulcers, and chronic gastritis, gout; hæmorrhages of various kinds, as epistaxis, hæmoptysis, hæmatemesis, hæmaturia, &c., dilatation, hypertrophy, and degenerations of the heart; hydrothorax, jaundice, nephritis, obesity, and œdema, paralysis of various kinds (*see* before), purpura, retention of urine, leading to cystitis, &c., spasms, tremors, with or without delirium or paralysis, uræmia, urinary diseases.

This list is not to be deemed exhaustive, and on the other hand, every one of the diseases, except perhaps delirium tremens, may occur in the most temperate and in total abstainers. *Cirrhosis* of the liver, for instance, is met with in sheep and lambs, and rarely in young children.

Diseases arising from deficiency or improper quality of the Food.

For details on this subject we must refer to works on the practice of medicine and on hygiène. As, however, the Merchant Shipping Act requires *lime-juice* or lemon-juice to be served out to sailors on long voyages, and also lays down a certain scale of diet, some idea of the principles on which this legislation is founded becomes necessary. The mortality from sea *scurvy* (*purpura nautica vel hæmorrhagica*), both in the navy and in the merchant marine was formerly frightful; "more seamen," as Dr. Tanner well says, "dying from it than from all other causes put together, not omitting the accidents of war." Thus, in 1726, Admiral Hosier sailed from England for the West Indies with seven ships of the line, and twice lost his whole crew from scurvy. Again, only two years after the sailing of Lord Anson's expedition from England in 1740, this disease proved fatal to four out of every five of the original crews. And again, in 1795, Lord Howe narrowly escaped losing the whole channel fleet, so much weakened by scurvy were his men. Although it is now practically extinct in the navy,* yet unfortunately, too many cases still occur in the merchant service. In Dr. Barnes' "Report on Scurvy" in this service it appears that from 1852 to 1863, 1,058 cases of this disease were admitted into the *Dreadnought* Hospital Ship. Although fatigue, despondency, and other causes may predispose, it is pretty certain that the absence of fresh vegetables, fresh fruits, and fresh meat from the diet is the principal cause. Of these, the most important are *fresh vegetables.* As early as 1757, Dr. Lind showed the efficacy of oranges and lemons in preventing this disease, but forty years elapsed before the Government made the use of lime-juice compulsory in the navy.† It is not yet known how this prevents the disease. Potatoes and other fresh vegetables, especially the cruciferæ, and most fruits have a similar power. They all contain citric and malic acids, potash, lime (calcic oxide), magnesia, lithia, soda, and some sulphur, phosphorus, and iron. Fresh meat alone is not nearly so efficacious, nor will any of the chemical substances just named either prevent or cure the disease. Several of them, however, prove beneficial, especially the citrate of potash, and different forms of iron.* A similar disease to sea-scurvy is often met with from similar causes in inland places. It is sometimes confounded with purpura. *Rickets* appear to be due to a deficiency in lime-salts, phosphates, fatty materials, and iron, if we may judge from the remedies which prove beneficial. *Relapsing fever* and typhus are greatly favoured by insufficient diet, the former has gained the name of famine fever.

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* Although four lives were lost in the late Arctic expedition of 1874–6, under Captain Nares, it appears that the regulations as to lemon-juice had not been complied with; and, therefore, this fact does not really invalidate the statement in the text.

† *Lime*-juice is the juice of the *Citrus limetta*, whilst *lemon*-juice is derived from the *Citrus limonum*, or lemon-tree. Although the linden (sometimes called "lime-tree") has antiscorbutic properties, it is quite a different plant from the one named above, which is known as the lime-tree in the West Indies.

Dysentery and *diarrhœa* (or English Cholera), also spring up where the diet is deficient. In 1823 the prisoners in Millbank Penitentiary had their allowance of food suddenly reduced from about thirty-two ounces of dry nutriment daily to twenty-one ounces; animal food being almost entirely discontinued. Although the prison was cold, and situated at a low level, in a marshy district, it was previously considered a healthy one. But soon after the change, the health of most of the inmates gave way. They lost colour, flesh and strength; then had diarrhœa, dysentery, and scurvy; lastly, adynamic fevers, or headache, vertigo, convulsions, maniacal delirium, and sometimes apoplexy. The smallest loss of blood produced fainting, which was often fatal. Out of

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* Boussingault's researches ("Ann. de Chimie et de Physique," Dec. 1872) on the amount of iron contained in various diets, renders it very probable that fresh vegetables and fresh meat owe much of their usefulness as food to the *iron* they contain. Thus, whilst 100 grammes of fresh human blood contain 0·051 grammes of iron in a metallic form, an equal bulk of beef equals 0·0048 of metallic iron, white wheaten bread nearly the same, potatoes 0·0016, green leaves of cabbage 0·0039 against 0·0009 in the white leaves. The green leaves of most plants and trees contain more iron than blanched ones. Whilst the diet of the French Navy contains per ration (per diem) 0·0661 gramme, and that of the soldier 0·0780 gr., the diet of an English "navvy" working on the railway near Rouen was as follows, according to MM. Gasparin and Boussingault :—

Substance.	Amount.	Iron in parts of a gramme.
Bread	24 ounces	0·0360
Meat	20 ,,	0·0312
Potatoes	32 ,,	0·0160
Beer	70 ,,	0·0080
Total of Metallic Iron		0·0912

This quantity equals about 1½ grain of metallic iron in the daily ration. The ration or daily allowance of a French sailor is as follows :—

Substance.	Amount.	Iron in parts of a gramme.
Bread or Biscuit	24 ounces	0·0360
Fresh Meat (or a corresponding amount of Salted Meat)	9½ ,,	0·0144
Beans or Lentils	4 ,,	0·0101
Coffee (infused)	½ ounce	—
Butter	½ ,,	—
Olive Oil	¼ ,,	—
Cabbage (dried)	½ ,,	0·0005
Wine	15 ounces	0·0051
Brandy	2 ,,	—
Salt	6 drams	—
Total Iron (grammes)		0·0661

Or, about one grain—a little less than in the case above.

860 prisoners, 437, or 52 per cent. were thus affected. It was found that those employed in the kitchen who had 8 ounces extra of bread per diem, were almost exempt (only three attacked), and further that the addition of 8 ounces to the daily amount of vegetable food, and half an ounce to the animal, greatly facilitated restoration to health [Dr. Latham on "Diseases in Millbank Penitentiary," 1824; Carpenter's "Physiology," pp. 96-7]. During the late American Civil War, Dr. Jones made similar observations on 30,000 Federal prisoners confined in Camp Sumpter. Here the diet was only one of the causes, but undoubtedly a powerful one. Diarrhœa, dysentery, scurvy, and hospital gangrene prevailed. *See* Austin Flint's "Physiology of Man," vol. ii., p. 39, 1867, and the "Ann. de Hygiène," Jan., 1849, for similar observations at the Maison Centrale of Nîmes, by M. Boileau-Castelnau. Another experiment on a gigantic scale was made in the siege of Paris in 1870. The general effects of the deficiency of food are well sketched by Dr. Letheby. "A deficiency of food, especially of the nitrogenous part, quickly leads to the breaking-up of the animal frame. *Plague*, *pestilence*, and *famine*, are associated with each other in the public mind, and the records of every country show how closely they are related. The medical history of Ireland is remarkable for the illustrations of how much mischief may be occasioned by a general deficiency of food. Always the habitat of fever, it every now and then becomes the very hot-bed of its propagation and development. Let there be but a small failure in the usual imperfect supply of food and the lurking seeds of pestilence are ready to burst into frightful activity. The famine of the present century is but a too forcible illustration of this. It fostered epidemics which had not been witnessed in this generation, and gave rise to scenes of devastation and misery which are not surpassed by the most appalling epidemics of the middle ages. The principal form of this scourge was known as the contagious famine fever (typhus), and it spread, not merely from end to end of the country in which it had originated, but breaking through old boundaries, it crossed the broad ocean, and made itself painfully manifest in localities where it was previously unknown. Thousands fell under the virulence of its action, for wherever it came, it struck down a seventh of the people, and of those whom it attacked, one out of nine perished. Even those who escaped the fatal influence of it were left the miserable victims of scurvy and low fevers. Another example, not less striking, of the terrible consequences of what may be truly called famine, was the condition of our troops during the early part of their sojourn in the Crimea in 1854. With only just enough of food to maintain the integrity of the system at a time of repose and of ordinary temperature, they were called upon to make large muscular exertions, and to sustain the warmth of the system in the midst of severe cold."

In this gradual form of starvation, there is not generally much *hunger*, or, if present, it soon disappears, and may be succeeded by loathing of food. The chief symptoms are those of depression of the nervous system. Languor, despondency, listlessness, slowness, hebetude, and incoherency of thought, sometimes hyperæsthesia, and extreme tendency to start at noises, bright light, &c. There are vertigo, syncope, delirium, perverted and weakened sight, and epileptiform or apoplectic fits, ending in coma, which may be fatal. The bowels are costive in some cases, relaxed in others. The temperature, perhaps slightly raised at first, becomes lower. There is often distressing palpitation with *tinnitus* *aurium*, and temporary blindness, with ocular spectra. These symptoms will be detailed in some of the illustrated cases.

Food of bad quality may produce actual symptoms of *acute poisoning.* (*See* Sausage Poison, Poisonous Fungi, &c., pp. 541-549, and pp. 302 to 309.) The poisonous effects of *ergot* (*nervous ergotism* and *gangrenous ergotism*) have been described at p. 303. *See* also Aitken, *loc. cit.*, pp. 764-8 ; and the "Medical Press and Circular," June 5th, 1872. *Goitre* is supposed to be due in part to bad water [a recent theory being that the water contains sulphides].

Some forms of *vetch*, used as food (*Lathyrus sativus*, and *L. cicera*), appear sometimes to cause paraplegia. They are said to be injurious only when they form above one-twelfth part of the food, and produce paralysis only when at least one-third of the food is composed of these vetches. [Aitken, *loc. cit.*, p. 800. *Vilmorin*, "Ann. d'Hygiène," April, 1847, p. 469.]

Pellagra [Mal Rosso, Male della Vipera, Risipola Lombarda; *Mal de la Rosa* in Spanish] is a red eruption attended with great debility, nervous exhaustion and melancholia ; and going on to cramps, convulsions, vertigo, rigidity of muscles, thickening and pigmentation of the skin [hence Dr. Mason Good's name of *Elephantiasis Italica*] which are succeeded by marasmus, and colliquative diarrhœa, or dropsy ; or death occurs from some acute inflammation, or from successful attempts at suicide. It is believed to be caused by the sporules of a fungus [the sporisorium maidis] attacking maize, the chief food of the peasants in Lombardy. [*See* Professor Mayr's article in Hebra's "Skin Diseases," vol. i., p. 293, New Syd. Society's translation ; also Mason Good's "Study of Medicine," vol. iii., p. 433.] Other affections have been ascribed to the use of food of bad quality, or all of one kind, and that not sufficiently nutritious. For example, the *exclusive use of rice* as an article of diet is known to favour, if it do not produce, the *ulceration of the cornea* so common amongst Hindoos. *Shell-fish*, even when of good quality, *are the cause of urticaria* in some persons.

Gout is known to be greatly *favoured by the use of malt liquors* [ale, beer, and stout, or porter] *sweet and acid wines* [such as port and champagne], and by indulgence in a *highly nitrogenised diet ;* whilst *rheumatism* is ascribed by some to the *mal-assimilation of farinaceous and starchy foods.* There seems, however, to be very little evidence as regards this last point. Dr. Carpenter ascribes the *scrofulous* diathesis to the absence of *oleaginous* articles of food, whilst it is a matter of common experience that an excess of these tends to produce that form of dyspepsia known as *biliousness.* An excess of *nitrogenous* articles of diet is believed to develop *arthritic diseases*, if not *gout* itself. The power of sustaining enormous blood lettings with little inconvenience possessed by some of our ancestors has been ascribed to their liberal use of flesh-meat. If this be so, and there is little reason to doubt it, we can understand how useful were the frequent fasts prescribed by the Church, even in a bodily point of view. Although the principles laid down as to variety of food are undoubtedly true for the mass of mankind, and when dealing with the diet of numbers, it is better to err on the safe side, or that of plenty, than on the dangerous one of deficiency ; yet there are instances of health and longevity attained on a very restricted diet. Of these the two best known are those of Cornaro (given by himself in a pamphlet which has been translated into almost all European languages), whose diet was only 12 ounces of solids, chiefly vegetable food, with 14 ounces of light wine. On this he subsisted with great comfort for fifty-eight years. The other is that of the miller of Billericay (Thomas Wood) reported to the College of Physicians in 1767 by Sir George Baker.* This miller is said to have sustained a remarkable degree of vigour for upwards of eighteen years upon no other nutriment than 16 ounces of flour (containing about 14 ounces of *dry* solids) made into a pudding with water, no other liquid of any kind being taken [by the mouth]. Few could adopt such a diet with advantage; yet, as we shall presently see, life, and some strength may be long sustained on comparatively meagre diet, especially if the supply of liquids is unrestricted. In some of the cases recorded, as in the two above, *more liquid is excreted by the kidneys than is taken by the mouth*, 50 or 60 ounces of urine being passed, whilst perhaps only about a third of that quantity of fluid is ingested. The explanation of this is the key to that sudden increase of weight in the case of jockeys and others, which would otherwise be inexplicable, except on the hypothesis of trickery. We quote the following from "Carpenter's Physiology," pp. 168-9, who gives original references.

"There are certain phenomena, which, if accurately recorded, cannot be accounted for in any other way than by admitting that, under particular circumstances, *a considerable amount of water may be absorbed from the vapour of the atmosphere.* The following are among the most satisfactory and circumstantial observations that have been adduced in support of this position. *Lining* observed that his body on one occasion increased in weight, during two hours, to the amount of 8½ ounces, allowance being made for the amount of fluid ingested during that time, and for the quantity passed-off by the urine, and by cutaneous transpiration. *Dr. Jurin* affirms that he ascertained an increase of 18 ounces to have taken place during a night passed in a cool room after a day's exercise and abstinence. It is stated by *Dr. Watson* that a lad at Newmarket having been almost starved, in order that he might be reduced to a proper weight for riding a match, was weighed at 9 A.M., and again at 10 A.M., and *he was found to have gained nearly* 30 *ounces in weight in the course of this hour, though he had drunk only half a glass of wine in the interim.* A parallel instance was related to the authors by the *late Sir G. Hill*, then Governor of St. Vincent: a jockey had been for some time in training for a race, in which that gentleman was much interested, and had been reduced to the proper weight; on the morning of the trial, being much oppressed with thirst, *he took one cup of tea and shortly afterwards his weight was found to have increased* 6 *pounds*, so that he was incapacitated for riding * * * * In a case of ovarian dropsy recorded by *Mr. Ford* it was observed that the patient, during eighteen days, drank 692 ounces, or 43 pints, of fluid, and that she discharged by urine and paracentesis 1,298 ounces, or 91 pints, which leaves a balance of 606 ounces, or 38 pints, to be similarly accounted for." Should such a matter become ground for medical evidence, in connection with racing matters, you would expect to find (in addition to the evidence of credible witnesses, which is rather a matter for the Court than for you) the following conditions:—

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* This physician is best known for his researches into the true pathology and etiology of the *Colica Pictonum*, or lead colic, of Devonshire and other cider countries.

1st. A previous course of privation, exercise, or sweating, so as to predispose to absorption.

2nd. It should be shown that the air did contain a considerable amount of watery vapour. In these days of meteorological researches, such hygrometric observations are easily to be obtained.

You may be asked how much it is possible to eat at one meal? It is difficult to place a limit to the rapacity of gluttons and lunatics with inordinate appetites! Captain Parry's Esquimaux devoured no less than 35 pounds of various aliments, including tallow-candles, in twenty-four hours. A Hindoo is said to have eaten a whole sheep at one time. Sir John Franklin states that the half-breed *voyageurs* of Canada are very discontented when put on a short allowance of 8 pounds of meat a day, their usual consumption being from 12 to 20 pounds! The wandering Cossacks of Siberia, according to Captain Cochrane, are not much less hearty! [Carpenter, *loc. cit.*, p. 85. We must refer to the same pages for a description of the diet and methods employed by the celebrated trainer Jackson—foot-note to page 86, *loc. cit.*] Having thus stated the general principles of dietetics, and the general consequences of diminished or improper food, we shall proceed to discuss in detail the

Symptoms and Proofs of Starvation in the Dead and in the Living.

If Bulwer's hero had ever completed his "History of Human Error," one of the most remarkable of its chapters must have been the one which treated of belief in impostors who pretended to fast, and disbelief in real cases of long abstinence from food. The spirit of incredulity has extended so far as to deny the fasting of Moses, Elijah, and the founder of Christianity,* whilst, on the other hand, the populace has believed in a *six years' fast* (*!*) by Anne Moore of Tetbury (1807), and in the divine mission of Elizabeth Squirrel, the so-called "Shottisham Angel," of Woodbridge, Suffolk; and its credulity in the case of the Welsh fasting-girl, Sarah Jacob, led to the death, one had almost written murder, of this poor girl. We shall return to these cases presently, and mention the principal general phenomena of starvation. These are:—

1. The *temperature is lowered in cases of starvation.* Chossat's experiments will be found in his "Recherches expérimentales sur l'inanition," a memoir presented to the Academy of Sciences in 1843. For other references, see Wunderlich on "Temperature," New Syd. Soc.'s translation, pp. 135-6. If food be taken after fasting the temperature will be raised. You must not, however, except just before death, expect to find very low or collapse temperatures. The general depression is rarely more than from ½ to 2 degrees F. (= 0·3° to 1·1° Cent.). Not knowing this led some of the medical men wrong in *Sarah Jacob's* case. It is very probable that in some stages of fasting there is a slight increase of temperature [slight pyrexia]. The loss of temperature is most remarkable on the last day of life, when it sometimes amounts to several degrees (collapse). Dr. Carpenter shows that in Chossat's experiments the daily *variation* or *fluctuation* of temperature was greatly increased.

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* It is to be noted here that the Scripture narratives nowhere claim these facts as miraculous, although supernatural events may have preceded or followed them.

2. *The pulse is affected.* At first it is a little quickened; afterwards it becomes slower, and then on the approach of danger it becomes greatly quickened. On this point Dr. Fowler* remarks, "Assuming the average pulse of Casper's prisoner to have been from 70 to 75, as it ordinarily is at that age, we get on the fifth day of absolute starvation a rise of from 13 to 18 beats per minute, which, on the eighth day is augmented by 8 more, or in all about 21 or 26 beats over and above its natural rate. On the second day of the fasting Sarah Jacob's pulse had increased 14 beats; on the third 26 beats, on the fifth 54 beats, and on the 7th day 74 beats in rapidity. Sex and temperament may have something to do with this dissimilarity." Dr. Fowler then proceeds (p. 244-5) to account for the apparently normal rate of 76 on the tenth day, in Casper's prisoner, as it appears he had then taken some sugar and water.

In the case of the pitman, to which we shall presently come, the atmosphere of impure gases may, he says, have contributed to the slow pulse-rate.

3. *The body loses weight.* In the case of the fasting woman of Tetbury, Anne Moore, this led to the detection of the imposture. "The average loss of weight in the warm-blooded animals experimented on by M. Chossat, between the commencement of the period of inanition and its termination by death was 40 per cent.; but he met with a considerable variation in the extremes, which seemed to depend chiefly on the amount of fat previously accumulated in the body; those animals losing most weight in which the fat had been most abundant, which were also those that lived the longest. Taking 40 per cent. as the mean, M. Chossat obtained the following curious results, as regards the relative diminution of the several tissues and organs of the body, those which lost more than the mean being distinguished from those which lost less:—

Parts which lose *more* than 40 per cent.		Parts which lose *less* than 40 per cent.	
Fat	93·3	Muscular Coat of Stomach	39·7
Blood	75·0	Pharynx and Œsophagus	34·2
Spleen	71·4	Skin	33·3
Pancreas	64·1	Kidneys	31·9
Liver	52·0	Respiratory Apparatus	22·2
Heart	44·8	Osseous System	16·7
Intestines	42·4	Eyes	10·0
Muscles of Locomotion	42·3	Nervous System	1·9

The general accuracy of these observations is admitted by most of his critics. The following are perhaps open to more objection, as being founded on birds (turtle-doves), whose ages were estimated by their weights:—

Ages.	Daily proportional loss in 1000 parts.	Duration of Life in days.
α. Young	0·081	3·07
β. Middle-Aged	0·059	6·12
γ. Old	0·035	13·36

We shall mention the question of age further on. Emaciation will be more marked in cases of prolonged, chronic, or semi-starvation, and less marked in cases of death from acute starvation, or entire absence of food.

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* "A Complete History of the case of the Welsh Fasting Girl (Sarah Jacob), &c.," by Robert Fowler, M.D., Edinburgh. H. Renshaw, London, 1871.

The want of emaciation was made much of in Sarah Jacob's case. There was, however, no doubt that she lost flesh. See Dr. Fowler's work, p. 228, &c. In the case of Anne Moore of Tetbury Mr. Francis Fox wisely suggested that she and her bed should be placed on a weighing-machine. This detected the daily loss of weight.

The table given by us at page 623 will guide you as to what ought to be the weight at a given age. In using it you must allow for premature birth, for congenital syphilis (which has a great tendency to retard growth, development, and puberty), and for the existence of any diseases, such as phthisis, tabes mesenterica, or recent attacks of fever, which would all tend to produce a less weight than the average of normal healthy cases. To illustrate our meaning take the following case from a recent daily paper.

THE ALLEGED CRUELTY TO A NIECE.—Mrs. Sophia B——, a lady of good position, residing in a fashionable suburb of Bristol, was yesterday committed for trial for neglecting to supply sufficient food and clothing to Caroline H——, her niece and in her charge. The defendant is alleged to have kept complainant without food. The complainant is sixteen years of age, but only weighed sixty-eight pounds."

Referring to our table at p. 623, we find that the—

Normal weight of females at sixteen years of age is	95·7	pounds,
Whilst the complainant's weight was only .	68·0	,,
There was therefore a deficiency of . .	27·7	,,

or nearly a quarter of a hundred-weight, a deficiency which, unless explained by some severe disease, such as phthisis, &c., was in itself *primâ facie* evidence of insufficient food having been given. In using the table read the remarks on page 624.

4th. *A fœtid odour is exhaled from the skin and mouth, &c.* This was noticed in nearly all the cases. In the case of the Welsh Fasting Girl Sarah Jacob, the "sister" Nurse Clinch, "first perceived a strange smell, a peculiar smell, about the bed" on the sixth day of the watching and entire abstinence from food; she says, "it was not like the usual smell of death, and I cannot describe what it was like." It was not urine, nor from the feathers of the new bed, for "after the bed was changed, I still perceived the smell." Beck calls it "a fœtid, acrid smell, Dr. Donovan (speaking of the Irish famine), calls it "an offensive odour"—some authors say, "an odour sui generis." In some cases (especially chronic starvation), the skin becomes covered "with a brownish filthy-looking coating, almost as indelible as varnish" [Dr. Donovan]. The skin sometimes adheres to the bones, it is almost always harsh and dry, particularly so in chronic starvation. Graziers and horse-keepers are familiar with the condition of integuments known as "hide-bound." The skin may hang in loose folds. The bones are prominent. The orbits, the neighbourhood of the zygoma, and the neck and thorax soon show this starved appearance. Old nurses and doctors are familiar with the fact that the nates exhibit emaciation more than some other parts, as in Horace's shameful caricature:

"Hietque . . . . inter aridas nates
Podex, velut crudæ bovis."

5th. *Minor signs of starvation are*—Wild and glistening eyes, glassy and fierce-looking, generally with dilated pupils; the mouth dry and parched, with thick, tenacious saliva; the breath sometimes hot, but on the approach of dissolution, quite cold, this is sometimes so as long as a week before death; the mucous membrane of the outlets (anus, vagina, urethra, nostrils, &c.), becomes red and inflamed in some cases. There may be delirium and convulsions. In a few cases, chiefly in shipwrecked sailors, there has been violent excitement. Dr. Taylor ascribes this to either a tropical climate, or to the drinking of wine, spirits, salt-water, or of their own urine. He refers to Rostan and Orfila, "Cours Elémentaire d'Hygiène," vol. i., p. 283, &c., and "Médecine Légale," i., p. 415, and to Dr. Martyn, in the "Medical Times and Gazette," March 30, 1861, p. 344. There may or may not be intense pain in the stomach, relieved by pressure; though this is generally felt at first, and the feeling of intense hunger soon goes away. Intense thirst is a more lasting symptom in cases deprived of water or suitable drinks. There is always great muscular weakness in chronic starvation, and in the last stages of the acute form. There is a feeling of intense coldness all over the body. The voice becomes weak, and the intellect dull. There is drowsiness and this merges into coma in fatal cases. *The bowels are constipated;* or if fæces are discharged, they are in small quantity, dry, and dark-coloured; the *urine is scanty, high-coloured, and turbid* on standing, *i.e.*, concentrated. In a few cases, petechiæ, or purple extravasations have been noticed on the skin. Orfila's "Cours de Méd. Légale," p. 415.

You may be asked to answer the question:

How long does starvation take to kill?

The answer will depend upon a careful consideration of a number of factors. *The average period for death in complete privation of food would seem to be from seven to ten days* (Orfila, Casper, Taylor, Guy, Fowler, &c.). But much will depend on the surroundings, on sex, age, and previous health; and it is unanimously agreed that when those starved have access to fresh water and other liquids, life is prolonged much more than when thirst is added to hunger. The dictum of Hippocrates,* that, "The old bear the want of nourishment the *best;* they who have attained the middle period of life the *next in degree;* those who have just arrived at puberty are still *less* able to endure it; but of all ages, childhood is the *least* capable of sustaining hunger; and of children the more lively are the *least* capable," seems borne out both by experience and the experiments of Chossat and others. *Other things being equal, fat persons will bear privation longest.* Sarah Jacob was "a plump child" before the fatal watching began. The Dover pig was also a fat one.† The Castle Cliff fell on the 14th of December, 1810. There seems little reason to doubt that peculiar mental or psychical states enable partial and perhaps complete privation of food to be borne longer than it would be in health [religious ecstasy, hysteria, catalepsy or trance, and insanity]; *warmth* is also capable of taking the place of food to some limited extent. *The phenomena of hibernation or the dormant state* met with in the dormouse,[*] hamster, marmot, hedgehog, jerboa, frogs, serpents, lizards, and a few other animals [chiefly rodents, amongst the mammalia], bear some analogy with cases of starvation in human beings.[†]

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* Bellott's translation, "Aphorisms," Lib. I., No. 13:—"Γέροντες εὐφορώτατα νηστείην φέρουσι· δεύτερον, δι καθεστηκότες· ἥκιστα μειρακια· πάντων δὲ μάλιστα παιδία· τουτέων δὲ αὐτέων ἃ ἂν τύχη αὐτὰ ἑωυτῶν προθυμότερα ἐόντα."

† "There is a well-known case of a fat pig which was buried in its sty for 160 days, under 30 feet of the chalk of Dover cliff, which was dug out alive at the end of that time, reduced in weight from 160 pounds to 40 pounds, or no less than 75 per cent." ("Transactions of Linnæan Society," Vol. xi., p. 411.) This extraordinary prolongation of life may be attributed to the retention of the *heat* of the body by the non-conducting power of the chalk, and to the retention of its moisture by the saturation of the air in its immediate vicinity, and the restriction of its movements. (Carpenter's "Physiology," Note to p. 94; Horn's "Description of Dover," 2nd ed., 1819, p. 24.)

The longest authentic period of total deprivation of food in human beings appears to be about six weeks. *See* Illustrative Cases.

Post-mortem Appearances in Cases of Death from Starvation.

These are, for the most part, derived from the chronic cases. For this reason we have given the post-mortem examination of Sarah Jacob, an acute case, separately.

1. *The body is remarkably light* (*see above*), and is shrunken and emaciated.

2. *The skin is dry and shrivelled; has a disagreeable odour* (*see before*), and is free from fat; sometimes there is a kind of brown, varnish-like coating over it. It is difficult to separate the skin from the subjacent muscles, &c.

3. *The muscles are much wasted, soft, and devoid of fat.*

4. *The stomach and intestines are generally found collapsed, contracted and empty, and their mucous membrane is thin, and almost or quite transparent,* so that Dr. Donovan was once able to see a bit of raw green cabbage in the duodenum of a man who had died of starvation. The omentum also may be transparent. In some cases (as in Dr. Sloan's, to be quoted presently) the stomach and intestines are distended from gases. In other cases, says Dr. Martin (*loc. cit.*), the intestines are not only contracted, but shrunken and diminished in size, shortened in length as well as in calibre, and like a mere cord, as if the canal was obliterated.

5. *The solid viscera* [heart, lungs, kidneys, liver, &c.], are *small, shrunken, and anæmic.* The heart is not generally quite empty. Sir Thos. Watson says, "Accordingly after death by starvation, the heart is not found to be so much contracted, nor so nearly empty, as after death by sudden and copious hæmorrhage." "Principles and Practice of Physic," p. 65.

6. *The large blood-vessels are also comparatively empty.*

7. The *gall-bladder is generally full,* and there is cadavenic exudation of bile; the *urinary bladder on the contrary is generally empty.*

8. *As minor* signs may be noted, the sunken appearance of the face, like

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[*] "Tota mihi dormitur hiems, et pinguior illo
Tempore sum, quo me nil nisi somnus alit."
Martial, Lib. xiii., Ep. 59.

[†] Thus—(1) *Animal heat* is diminished (from 20° to 40°, or 50° F. in some), yet it is always higher than the temperature of the atmosphere in the winter months. (2) *The pulse,* and *consequently the heart-beats, are greatly diminished* (from 115 to 15) in the hamster!) Respiration is also much slower. Some seem to be a quarter of an hour without breathing—seldom breathing more than once in a minute on an average. (3) *Not only is digestion in abeyance, but the nervous system is in a singularly torpid state,* so that they seem almost insensible to pain, and can only be roused with difficulty from their comatose state. 4. *The weight is diminished* notwithstanding Martial's epigram, quoted above.

the *facies Hippocratica*, the open, staring eyes, generally with dilated pupils, the conjunctivæ sometimes red; the mouth, anus, and other outlets are red and inflamed-looking. Such fæces as are contained in the bowels are hard like bullets or pellets, and of very dark colour. Dr. Woodman has found the *thymus gland* more than usually large and persistent in infants and young animals who were badly fed.

ILLUSTRATIVE CASES.

CASE I.—*The Welsh Fasting Girl, Sarah Jacob. Death from Acute Starvation.*

For the symptoms and full account of this case we must refer to the "Complete History" by Dr. Robert Fowler, p. 307. The general outline is as follows:—She was born May 12th, 1857. Her father was a tenant-farmer, occupying a small farm called Llethernvyadd-ucha, in the parish of Llanfihangel-ar-Arth, Carmarthenshire. She is said to have been a very pretty and intelligent child, and fond of reading. She had a dyspeptic attack in February, 1867, about a year after a mild attack of scarlet fever. During this six weeks' illness she had some convulsions of a tetanic character (opisthotonos), "with rigidity of the left leg," and "for nearly a month, of all the muscles." During the same year there appears to have been repeated abstinence from food for longer or shorter intervals. But from October of this year till her death on December 17th, 1869, a period of two years, two months, and one week, it was affirmed that she ceased to take any food whatever! But all that time, except the last week, she continued plump, and even gained flesh. It was only during the last week that any efficient watch was kept, and then she died, owing partly to obstinacy on the part of her parents, who had made money by exhibiting their daughter, "dressed like a bride," and partly to the mistaken zeal of the nurses, in carrying out their instructions to the letter; partly, it must be owned, to a sad error of judgment on the part of some of the medical men concerned, who allowed their zeal for science, in order to disprove the imposture, to overcome their humanity. To the credit of one of them, Mr. H. H. Davies, it must be said, that he did interfere, and told the parents her danger and their duty. It is a pity he did not appeal to the magistrates. A singular feature in this case was, that a committee, comprising magistrates, clergymen, medical men, and editors of newspapers, had been formed to discover the imposture. This Committee had engaged the nurses who so effectually watched her till the poor little victim of her own hysteria and her parents' cupidity, died; which happened on the eighth day of the watch. This supervision commenced at 3 p.m. on December 9th, 1869, and she died on the 17th at a few minutes past 3 p.m. So that she was entirely without food for seven days. The father and mother were tried at the Carmarthen Summer Assizes in 1870 (*Regina* v. *Jacob and Wife*), and convicted of causing the death of their child by criminal negligence. The father was condemned to twelve months' imprisonment, and the mother to six months. The medical men who accepted the responsibility of superintending the watching were summoned to appear before the magistrates on the charge of "killing and slaying Sarah Jacob," but were acquitted, partly because neither the nurses nor the committee appear to have asked their advice, but chiefly, as we think, because of the humanity of one of them, Mr. Davies, which we mentioned before. The prosecution were at first inclined to summon the whole committee. *The post-mortem appearances were as follows:*—The body was plump and well-formed, with signs of incipient puberty (she was a little more than twelve and a half years). Beneath the skin of the chest and the abdomen there was a layer of fat, of about three-fourths of an inch in thickness on the average. The brain itself was healthy and firm, but the membranes were much injected. The contents of the thorax were healthy, but contained very little blood. The stomach contained about three teaspoonfuls of dark gelatinous fluid, having a slight acid reaction to litmus paper. The small intestines were empty, but the colon and rectum contained about half-a-pound of fæces in a hard state. The medical men who made the examination judged that the fæces might have been there a fortnight or even much more. The liver was healthy, the gall-bladder considerably distended with bile, the kidneys and spleen perfectly sound, urinary bladder empty. On looking at the girl's shoulders and armpits, the right shoulder was found to be much more prominent than the other, the *left armpit being very hollow, sufficiently so to contain a half-pint bottle.* Dr. Fowler had given his opinion, when he first saw her, that the girl was a night-feeder, and that the parents were themselves deceived at first; and afterwards discovering that visitors gave money, and that the thing could be made profitable, they were tempted to carry on the imposture.

CASE II.—*Acute Starvation. Death on the Thirteenth Day of Complete Abstinence.*

"In February of 1862 a man, thirty-six years of age, was discovered in a stack, near Morpeth, dying from starvation. All attempts to rally him failed, and he ultimately died. He was an intelligent man, and had been editor and proprietor of a penny journal called the "Falkirk Liberal." A diary was found in his possession, containing entries of his condition from the 8th to the 25th of February, from which it appeared that during *seventeen* days he had twice tasted a piece of bread; but for the last *thirteen* days he had been entirely without food. During the first *ten* days of the thirteen he was able to obtain water, but on the *eleventh* day he found his legs were useless, and *he lost all* motor power in the lower extremities, so that 'one-half of his body appeared to be dead.'"

The case is of interest to the pathologist as showing the length of time during which existence can be maintained if water alone be taken. [Aitken's "Science and Pract. of Med.," p. 744.]

CASE III.—*Voluntary Starvation by a Prisoner. Life Prolonged to Fifty-eight Days.*

[Van Swieten's "Commentaries upon Boerhaave's Aphorisms," p. 329; Beck, Guy, Fowler, &c. See also the American "Cyclopædia of Practical Medicine," *art.* "Abstinence," by Dr. Hays. "Foderé," vol. ii., p. 276.]

"Guillaume Granet, a prisoner at Toulouse, resorted to starvation to avoid punishment. For the first seven days the symptoms were not very remarkable; his face was flushed, his breath foul, and his pulse small and feeble. After this period he was compelled to drink water occasionally to relieve the excessive thirst which he suffered, but in spite of the close watch kept over him he frequently drank his urine, or the water of the prison kennel. His strength did not appear to fail him during the greater part of the time, and with varying symptoms of constitutional disturbance and acute sufferings *he lingered till the fifty-eighth day*, when he expired, after struggling four hours in convulsions. At the *post-mortem* examination the brain was paler than usual, the lungs nearly natural, œsophagus contracted, but not the stomach, which contained a little fluid ; the lower portion of the small intestines red, softened, and highly injected ; large intestines natural, and containing fæcal matter ; the gall-bladder much distended with black thick bile ; the muscles much attenuated."

CASE IV.—*Dr. Sloan's Case of Incarceration in a Coal Mine for Twenty-three Days.*

[" Medical Gazette," vol. xvii. (Nov. 21, 1835), pp. 264 and 389.]

This case is reported in nearly all the text-books. Dr. Sloan (of Ayr) mentions this case, " of a man aged sixty-five, of a spare habit of body, and uncommonly vigorous for his time of life," who was brought alive out of a coal-mine, in which he had been incarcerated *twenty-three days.* During the first days he had access to water " strongly impregnated with iron." " After that period he became so weak as to be unable to move, and he had unfortunately laid down at some distance from the water." In commenting on this case Dr. Sloan remarks that " an atmosphere slightly impure, by lowering the vital powers, might tend to prolong life under privation of food."

CASE V.—*Case of the Captain and Crew of the Jane Lowden, timber Vessel. Various Periods of Death.*

" A very detailed and evidently faithful account " (says Dr. Guy) " of the picking-up at sea of Captain Casey, commander of the *Jane Lowden*, timber-vessel, shows that out of eighteen men, including the captain himself, wholly without provisions and fresh water, one survived eleven days, one twelve days, one fourteen days, two fifteen days, one eighteen days, and the Captain himself twenty-eight days. Two men appear to have died early, furiously delirious, one (a lad of nineteen), who died on the twelfth day, was quietly delirious, with spectral illusions ; two others were delirious, and Captain Casey had illusions of hearing." When picked up the captain " was pale and thin ; " he sustained life " by drinking as much rain as he could collect by tying his cravat around the mast, and when it became drenched, sucking it." See the " Times," February 6th and 7th, 1866.

CASE VII.—*The Fasting Woman of Tetbury, Anne Moore. Imposture detected by the Weighing Machine.*

This case has already been referred to in the text, and is quoted by Beck (p. 34), Taylor (p. 143), Fowler (p. 269, notes), and others.

" About sixty years ago, at Tutbury or Tetbury in Staffordshire, certain respectable inhabitants of the place volunteered to discover whether or not Anne Moore, a woman about middle age, subsisted, as was declared, without the ordinary nutriment of her kind. This watch was continued for about three weeks, when it was publicly proclaimed that the Tutbury woman 'lived entirely without food.'[*] In this case the Bible was always open before the patient in the bed. Her emaciation was said to be so extreme that the spinal column could easily be felt through the abdominal walls. Her distaste to aliment, it was alleged, resulted from a nausea and disrelish produced by her washing the linen of a person afflicted with ulcers. In consequence of the *éclat* derived from the unsuccess of the watchers, numerous visitors, some from long distances, visited Anne Moore during the next *two* (or, according to others, *six*) years, leaving, of course, their donations in the house; to the extent of about £250. [Beck says, on the authority of Dr. Henderson, that she had placed £400 in the stocks.] In April or May, 1813, the woman consented to another watching being instituted, provided the Watch Committee was composed of magistrates, clergymen, and medical men. Amongst these were Sir Oswald Mosley, bart., D.C.L.; the Rev. Legh Richmond, Dr. Fox, and his son Francis, of Derby, and many other gentlemen of the neighbourhood. Two gentlemen were always in her room day and night. At the suggestion of Mr. Francis Fox, *the bedstead, bedding, and the woman in it were placed on a weighing-machine, which resulted in discovering that she regularly lost weight daily.* At the expiration of the *ninth day* of this strict watching Dr. Fox found her evidently sinking, and told her she would soon die if she would not take food. After a little prevarication the woman signed a written confession, that she was an impostor, and had "occasionally taken sustenance for the last six years." She also stated that at the first unsuccessful watch of three weeks her daughter had contrived, when washing her face, to feed her every morning by using towels made very wet with gravy, milk, and water, or a strong solution of arrowroot; and had also with every kiss managed to convey certain portions of sugar from mouth to mouth." Vide "Wilson's Wonderful Characters," and "History of Tutbury," p. 321-2.

Cases VIII. and IX.—*Two Prisoners Voluntarily Starve themselves, one for Nine, the other for Ten Days, and Recover.*

[The first case is from Casper ("Handbuch der Gericht Med.," 1857, 1, 374; "New Syd. Society's Translation," vol. ii., p. 28-29).]

A healthy male prisoner, aged thirty-six, after being in prison for a year, "vowed to God to eat nothing more in prison, come what may." On the fifth day his temperature was still normal, but his features were a little collapsed. He had singing in his ears; no delirium as yet. His bowels had not acted, and he had passed but very little urine. On the seventh day there was an ill smell perceived to come from his mouth. On the eighth day he had to be carried to the night stool. Pulse 96. His voice was hollow. On the ninth day the smell from his mouth was more distinct. "On the tenth day his pulse was only 76, and very feeble. He complained of double vision, and spasms of the stomach, relieved by strong pressure. Yesterday afternoon and this morning early he had, from absolute necessity, now and then taken a little sugar and water, and used in all about six ounces. Everything to-day smells of milk! and in the night, between this day and the next, hunger suddenly seized and overpowered him, and he ate a little of yesterday's allowance of bread, which still lay near his bed." This man then took to his proper food, and ultimately quite recovered.

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[*] The first watch in the case of *Sarah Jacob* (the Welsh fasting girl), failed to detect that she took any food. They watched her for fourteen days by turns. These watchers were men. It was rumoured that one was one night found asleep at his post; another had to go home in consequence of the effect of some gin. (Fowler, *loc. cit.*, p. 25.)

The woman's case was communicated to us by Dr. J. L. Lavies. She was a prisoner in the Westminster House of Correction, a young adult, who, out of pique or dislike to the prison fare, vowed to take no food at all. She kept to her resolution for *nine* days. On that day her pulse began to flag, but just as Dr. Lavies was anticipating danger her resolution gave way, and she asked for food and took it. No bad symptoms followed.

Other Cases of Starvation.

Mr. Charles Lingen, Surgeon Extraordinary to the Hereford General Infirmary, has recorded the case of "a thin spare man, in fair health," who persisted in absolute avoidance of all solid and liquid food, and in whom death occurred on the *tenth* day. [" British Med. Journal," April 16, 1870, p. 384.]

Viterbi's case of voluntary starvation, life prolonged for *twenty-one* days. [Guy, *loc. cit.*, p. 328.]

Van Swieten's case of refusal of food by a melancholic patient for *six* weeks (*forty-two days*). He says in his "Commentaries," "I knew a woman who obstinately refused all kinds of nourishment for *six weeks*, drinking nothing but a little water at intervals, so that at length she perished quite juiceless and dried up."

Dr. McNaughton ["Transactions of the Albany Institute," vol. i., p. 113] gives the case of Kelsey, who lived for *fifty-three days* on water alone; the stomach was loose and flabby, and the mesentery, stomach, and intestines, extremely thin and transparent; the gall-bladder full, &c." Beck, note to p. 519. *Beck* gives several other references in this and the succeeding page.

Dr. Cummin's case of *Elizabeth Canning* ["Medical Gazette," vol. xix.]. In this case the question was, could a girl of eighteen be confined for twenty-eight days in the depth of winter, without fire, with about a gallon of water in a pitcher, and with no food but some pieces of bread, amounting altogether to about a quartern loaf, and a small mince-pie, which she happened to have in her pocket; and at the expiration of the period retain sufficient strength to break down a window shutter fastened with nails, get out of the window on to a sort of pent-house, thence jump to the ground, nine or ten feet below, and finish by walking from Enfield Wash to Aldermanbury?" Dr. Guy, who thus puts the question, justly returns an answer in the negative. It is possible life might be prolonged, but in all the recorded cases the muscles have become so weak before half the time mentioned, that the sufferers could not even help themselves to water, much less walk this distance.

Mr. Bigg's description of the post-mortem appearances in the case of *Mark Cornish*, starved by his father and step-mother. [See Guy, *loc. cit.*, p. 330; "Morning Chronicle," Feb. 26, 1853; Fowler, p. 256.] Insufficient food for about three months with ill-treatment. Post-mortem appearances as usual. Body a mere skeleton, *omentum as clear as glass* No chyle."

Dr. Guy's case of Shipwreck on the Calcutta coast. Ten out of thirteen men escaped and recovered after being *twelve days* without food or water. No mention made of *rain*-water. *Loc. cit.*, p. 329.

Irish Famine Cases. Dr. Donovan in "Dublin Medical Press," Feb. 2, 1848. Taylor, *loc. cit.*, p. 141.

Dr. Henry Barber's cases of long-continued abstinence from food, with hysteria and lethargy. ["British Med. Journal," May 28th, 1870.] *Eleven months* and *twenty-six* weeks ! ! ! These cases were probably night feeders at first. The first only died. [Fowler, p. 201.]

Dr. Williams of Sudbury records two cases in the "Lancet," April 24, 1869, p. 563 ; Fowler, p. 248.

Siege of Paris in 1870. "Lancet," Feb. 11, 1871, p. 214. Other references in Fowler, p. 304-5.

Dr. Charles Thornhill's case of eight men and a boy shut up for *eight days* in a coal-mine. ["Med. Gazette," vol. xvii. (Nov. 28, 1835), p. 390.]

Dr. Ogle's cases of hysteria and pretended fasting. ["British Medical Journal," July 16th, 1870, p. 57 ; Fowler, p. 296. (Notes.)]

Dr. Fowler's case of a lady, aged seventy-nine, taking only water for three weeks before death, *loc. cit.*, p. 201.

Foderé's workmen, dug out alive after fourteen days' confinement in a cold damp vault, in which they had been buried, under a ruin. [Carpenter, *op. cit.*, 98.]

The Shottisham Angel, Elizabeth Squirrel, detected by proposal to fire the house ! afterwards married ! [Fowler, *loc. cit.*, p. 284, notes.]

Louise Lateau, case of *Ecstacy*, "Macmillan's Mag." April, 1871, by Dr. G. E. Day, from original memoir by Dr. F. Lefebvre, Louvain, 1870, entitled "Louise Lateau de Bois d'Haine, sa Vie, ses Extases, ses Stigmates. Étude médicale." ["British Med. Journal," May 6, 1871.]

Case of the Patagonian Missionaries in 1851, see "Annual Register," 1852, p. 473 ; Fowler, p. 298. Captain Gardiner left a diary describing his own feelings and the sufferings of those who were with him. After nearly sixteen weeks of insufficient food, the captain, who was apparently the sole survivor, was six or seven days without any food at all, and appears to have died on the day of the last entry. Another instance of a whole party having insufficient nourishment occurred in Franklin's *Overland Arctic Expedition* in 1820-21 down the Coppermine river. They had to live on the *tripe de roche*, a kind of lichen or moss, shreds of their shoes, old deer-skins, and bones from the ashes, &c., in consequence of a snow-storm on Sept. 1st. By Nov. 6th they are said to have had emaciated figures, ghastly countenances, dilated eyeballs, and sepulchral voices. "After suffering acute pains of hunger all day, at night they were sated, in dreams, with every luxury. Their tempers grew so fretful that the kindest expressions were received pettishly, and Captain Franklin himself admits that he became excessively peevish. Each thought the other weaker in intellect than himself, and more in need of advice and assistance." "A Narrative of Arctic Discovery from the Earliest Period to the Present Time." By John J. Shillinglaw (Shoberl), 1850, quoted by Dr. Fowler, p. 299.

We have seen that Starvation may sometimes be adopted as a means of *suicide*, though few have the resolution to carry out such a plan. It is sometimes the means, or one of the means, adopted to punish or get rid of children and others, who have incurred the hate of malevolent persons. The notorious *Mrs. Brownrigg* is said to have starved some of her apprentices to death. It may, therefore, be adopted as a means of *murder*. More often the legal charge must be against the parents or guardians, or masters or mistress, for *neglect*, thus reducing the crime to one of *manslaughter*.

The defence raised is, in general, that death occurred from some bodily disease, and not from starvation. It was so in the case of *Regina* v. *Pryke* (Chelmsford Summer Assizes, 1840), quoted by Dr. Taylor; and again in *Regina* v. *Mitchell* (Oxford Lent Assizes, 1861), when the accused, a naval surgeon, was charged with the manslaughter of his female servant, a woman aged twenty-four, by withholding from her sufficient food. All the appearances were consistent with death from starvation, but the medical witnesses admitted that mal-assimilation of food might have produced similar appearances, and a defence of chronic diarrhœa was set up. The deceased's own statement went to show that food was not withheld from her, and on this ground the prisoner was acquitted. Dr. Taylor, however, considers her symptoms and post-mortem appearances proved that death took place from starvation, although the master may not have criminally withheld food from her.

With regard to servants and apprentices it has been held that the husband, and not the wife, is bound to provide food for them. [*Rex.* v. *Squire*, Starkie, vol. ii., p. 947.] But a wife may be, and sometimes is, charged as an accessory or accomplice in the crime.

Food must not only be enough in quantity, but the quality also must be suitable to the age and circumstances of the child or ward, servant, or apprentice, or other recipient.

Within a few years the numerous cases of *baby-farming*, which showed the public that one woman often took the charge of from three or four to thirty or forty young infants (chiefly illegitimate), and fed them on insufficient food, or improper food, so horrified the public, from the number of deaths that occurred, that a special Act of Parliament was framed to meet the case. The trials (*Reg.* v. *Mary Hall and Margaret Waters*) at the Central Criminal Court in 1871, showed that in addition to the use of improper food the children were often sadly neglected as to cleanliness, and drugged with preparations of opium to keep them quiet. It is now generally admitted by medical men, that *starchy* food, *per se*, is not a proper diet for very young infants; milk, and foods containing a proportion of nitrogen, being necessary for their growth and health. Several decisions of the Vice-Chancellor, and of the judges at the Central Criminal Court in trials of the "Peculiar People," &c., have shown that *medical attendance and medicines are considered necessaries, and that a husband is bound to provide them for his wife, and a parent for his or her child*, &c. The want of cleanliness in the case of lunatics, children, and sick persons, is very justly considered as an aggravation of the neglect to give sufficient food, although it would probably be difficult to find any express law upon this subject.

The Treatment of Starvation

may be briefly stated as follows:—When food is given to either children or adults who have long been deprived of it, it should at first be given in moderate or rather small quantities, and in a form easily assimilable:

such as beef-tea, good soup or broth, eggs, milk, wine and water, or weak spirits, gradually going on to fish, meat, bread and vegetables. Otherwise there is considerable risk of injury to those starved. We mention this, as you may be consulted in the case of men shut up in a mine, or rescued from shipwreck, and the popular idea generally is, that in such cases you can scarcely give too much!

Time required for Digestion of Food. Nature of Contents of Stomach.

The question, "*How long is it since a meal has been taken?* is not infrequently asked in medico-legal cases. The medical witness was asked about this in the *Blackburn murder*, in which a hair-dresser killed and mutilated a little girl called Holland.

Most of our knowledge of digestion is derived from the experiments of Dr. Beaumont on Alexis St. Martin, a Canadian, who had a gastric fistula in consequence of a gun-shot wound. The experiments of Dr. Gosse, and of Dr. Rawitz ["Spallanzani, Versuch über das Verdauungsgeschäft," Leipzig, 1875; and Weber's "Die Einfache Nahrungsmittel;" Breslau, 1876; and Dr. A. Combe's reprint of Dr. Beaumont's "Experiments and Observations on the Gastric Juice," &c., Edinburgh, 1838.] Dr. Beaumont constructed a table showing the times required for the digestion of all the usual articles of food in St. Martin's stomach, and in his gastric fluid taken from the stomach. Among the substances most quickly digested were *rice* and *tripe*, both of which were chymified *in an hour;* eggs, salmon, trout, apples, and venison, were digested in *an hour and a half;* tapioca, barley, milk, liver, fish, took about *two hours;* turkey, lamb, potatoes, pig, in *two hours and a half;* beef and mutton required from *three hours* to *three and a half;* and both were more digestible than veal: fowls were like mutton as regards their digestibility.

As a rule, animal substances were converted into chyme more quickly than vegetables. Dr. Rawitz used the microscope to examine the products of artificial digestion, and also the fæces after natural digestion. He found that the flesh of animals first breaks up into the constituent fasciculi of muscular tissue; these then divide transversely, gradually the transverse striæ become indistinct and disappear. Last of all, the sarcolemma seems to be dissolved, and scarcely any trace of the tissue is left. Fish and hares digest very rapidly; poultry and other animals more slowly. The cells of cartilage and fibro-cartilage (except those of fish) pass undigested through the stomach, and are found in the fæces. Elastic fibres are unchanged. As regards vegetable substances, spiral vessels, cell-membranes, chlorophyl, or green colouring matter, and starch cells, often appear unchanged in the fæces.

In general terms it may be said that *from three and a half to four hours, or more, are usually required for the digestion of a meal of mixed food.* In some cases some six or eight hours, or more, may be required. It will be remembered that the medical witnesses examined in the case of *Calas,* recorded at page 943, mistook the time required for digestion. Fish and some light articles of diet may be digested in about an hour.

In the case of the *Welsh Fasting Girl* it was assumed by Mr. Giffard, one of the counsel, that Mr. John Phillips, a medical witness, ought to have known whether the fragments of bone found in the fæces were those of a fish, bird, or of some other animal. He also assumed that polarized light ought to have been used in the examination of the starch corpuscles found. We do not blame barristers for doing the best they can for their clients; but we wish to caution you against pretending to more knowledge than you really have in the case of animal or vegetable *débris*, in fæces, the contents of the stomach, and the like. It is often possible to be perfectly sure, for instance, that you have *bone*, from the presence of the *bone corpuscles* figured at page 640, or of Haversian canals and systems; to recognise the spiral vessels, or stomata of plants, the elastic tissue of animal structures, and similar substances, and yet not to be absolutely sure as to the exact animal or exact plant from which these remains are derived. Whilst those who have made a special study of histology are sometimes able to attribute to their right source the fragmentary remains found in the contents of the stomach or bowels with an accuracy which surprises the uninitiated; it will generally be found that those who know the most are least inclined to hazard mere guesses as to the nature of fragments which do not tell their own story to the eye of the skilled observer. In any case, you will seriously err if, in giving your evidence, you hazard a guess, instead of confining your evidence to known facts.

As *starches* are mentioned in the cross-examination of the medical witness to which we have just referred, it may be as well to state, that it is usually not difficult for a skilled observer to state what kind of starch has been ingested in a given case. [Figures of various kinds of starches will be found in the "Micrographical Dictionary," plate xxxvii; also in Pereira's "Materia Medica;" Royle's ditto; Attfield's "Chemistry;" Parkes' "Hygiène," and other works.] The illustrations of the "Micrographical Dictionary," and of the quarterly and monthly journals of Microscopical Science, will prove of great service to those who are unable to get the opinion of experts as to the substances found in vomited matters, and those passed by stool, &c.

CHAPTER XXX.

The various forms of mechanical injuries—General definitions—Medico-legal questions—Dying declarations—Gun-shot and other wounds—Fractures, dislocations, and injuries of special regions and organs—Compression and concussion of the brain, maiming and mutilation.

Richard Wiseman, who lived in the reigns of Kings Charles I. and Charles II., and was Serjeant-Surgeon to the latter, defines a *Wound* as "*a solution of continuity in any part of the body suddenly made by anything that cuts or tears, with a division of the skin.*" He goes on to say that by skin he understands "not only the external cutis, but also the inward membranes of the gullet, ventricle, guts, bladder, urethra, and womb, all of which are capable of wounds from sharp instruments, either swallowed or thrust into them."* In other words, the solution of continuity may affect either the skin and subjacent parts or mucous membranes, and the parts lined by them. But this definition excludes so many mechanical injuries, that it has been proposed to use the word *lesion* for the general term. Beck states that "the term wound in legal medicine comprehends all lesions of the body, and in this it differs from the meaning of the word when used in surgery. The latter only refers to a solution of continuity, while the former comprises not only these, but also every other kind of accident, such as bruises, contusions, fractures, dislocations," &c. In *Moriarty* v. *Brooks*," Lord Lyndhurst, Chief Baron, said—"The definition of a wound in criminal cases, is an injury to the person, by which the skin is broken. If the skin is broken, and there was a bleeding, that is a wound." [6 Carrington & Payne's "Reports," p. 684.] On this Beck properly remarks, that a man may have a bone fractured from a blow, without any breaking of the skin. [Note to page 609.] Dr. Taylor remarks, that Wiseman's definition would include ruptures of internal organs, such as the liver and spleen, and burns and scalds, as well as simple fractures and dislocations. On applying to three eminent surgeons, he obtained the three following definitions:—

"A wound is—

1. "A solution of continuity, from violence, of any naturally continuous parts."
2. "An external breach of continuity directly occasioned by violence."
3. "An injury to the organic textures by mechanical or other violence."

The want of a legal definition formerly allowed the collar bone to be broken by a hammer or otherwise, provided the skin were not broken; and similar injuries to be inflicted, and yet the prisoner to escape, because this was not considered a wound. [*Reg.* v. *Wood*, Matthew's "Digest," p. 415.] Now, however, these lesions would be included in the second clause of the sentence, "shall by any means whatever wound, or *cause any grievous bodily harm to any person*," "and by any means other than those specified," &c., &c., "with or without any weapon or instrument." [*See* the Acts 1 Vict. c. 85; 14 & 15 Vict. c. 100; and §§ 11, 15, and 20 of 24 & 25 Vict. c. 100.] Some medical witnesses have held that there is no wound unless the skin be completely divided (as in the case tried in 1838, at the Central Criminal Court, in which a man struck the prosecutor a severe blow on the temple with a heavy stone bottle, which was broken by the blow, but failed to divide the skin completely). The skin is said to be about $\frac{1}{4}$ to $1\frac{1}{2}$ line in thickness, or from $\frac{1}{48}$ to $\frac{1}{8}$ of an inch. [Quain and Sharpey, Kölliker, &c.] Mr. Justice Talfourd held it absurd to suppose that so thin a thing as the skin could be broken internally without external wound. Analogy was against him, in the case of the inner coat of arteries, &c. Yet it is not our wish to insist upon undue refinements. It would be far better to accept the continental definition, that "a wound includes any personal injury, suddenly arising from any kind of violence applied externally, whether such injury is external or internal." On the other hand, all surgeons are agreed that a division of the true skin is a wound, whether it bleeds or does not bleed. Wiseman's definition prudently includes the mucous membranes, for very serious injuries may be, and have been, inflicted on the interior of the body, as in the rectum and vagina, in the throat, mouth, and nostrils, &c. But simple fractures and the like, and the rupture of internal organs, are still in a doubtful category as to being wounds or not. Yet Lord Denman's decision in the Queen's Bench, in November, 1847, includes them by implication. For in this case an application was made to the Court for a new trial, on the ground of misdirection on the part of the Chief Baron. An action was brought against a medical practitioner for negligence in the treatment of a *simple dislocation* of the arm. The words of the declaration were, that the plaintiff had employed the defendant, who was a surgeon, "for the treatment and cure of certain *wounds*, fractures, bruises, complaints, and disorders." In the application it was submitted that none of these words applied to the injury in question. Lord Denman, however, refused the rule, saying, "It is rather strange that the pleader should have omitted the most appropriate word; but we think the Chief Baron was quite right." Webster defines a wound as "a hurt given to the body or animal-frame by violence: an injury; a cut; a slash; laceration." So Milton, of the Fall:—

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* "Chirurgical Treatises," Book V., Chapter 1.

> "Earth felt the *wound*, and Nature from her seat
> Sighing through all her works, gave signs of woe,
> That all was lost."

We believe it would not be difficult to multiply quotations from the poets to show that the word *wound* is generally used in the sense of a lesion or injury. And although in simple fractures, the judges formerly held that these were not wounds [as in *Rex* v. *Wood*, quoted above. 4 C. & P., p. 381], yet several recent decisions of the judges [Chief Justice Denman, Justice Parke, &c.], in *Regina* v. *Smith*,* *Regina* v. *Warman*, and other cases, have overruled this, and held fractures of the lower jaw, skull, &c., without bloodshed, to be wounds. "There must be a wounding; but if there be a wound (whether there be effusion of blood or not), it is within the statute, whether the wound is *internal* or *external*."—Justice Parke. So that, as Dr. Taylor remarks, it may be reasonably supposed that ruptures of internal organs, as well as simple fractures and dislocations, will be considered as wounds. Archbold defines a wounding to be where "the violence is so great as to draw blood, by striking or stabbing with a sword, knife, or other instrument, or by shooting or striking with a cudgel, the fist or the like," whilst "a wound includes incised, punctured, lacerated, contused, or *gun-shot* wounds." ["Pleading and Evidence in Criminal Cases," 15th ed., by Welsby, pp. 567, 572.] In gun-shot wounds, as we shall presently see, there is often no hæmorrhage; at least at the time.

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* 8 Carrington & Payne, p. 173. See also 1 Denison, C. C., p. 183.

On the Element of Time in Relation to Wounds and other Injuries.

The London and North-Western Railway Company, who were held liable in the English Courts for damages in respect of the disastrous collision at Wigan, in 1873, have lately defeated an action brought against them in the Scotch Court of Session, by the widow of a commercial traveller, who was amongst the passengers killed. The Court upheld the Company's plea, that the cause of action having arisen in England, the action must abide the English law, under which *such actions, to be sustainable, must be brought within a year and a day of the death of the person killed.* The widow is, therefore, denied compensation for the loss of her husband.

Archbold states (p. 345), as regards the period at which a person dies from a wound, that the assailant shall not be adjudged guilty of homicide unless *death takes place within a year and a day after the infliction of a wound.* Although in practice this rule may generally work well, there can be no doubt, as Dr. Taylor says, that its principle is erroneous. He quotes a case from Dr. Reid's "Physiological Researches," p. 523, in which a man died from diaphragmatic hernia, from a stab received *fifteen months* previously. Other cases are recorded of death long after injuries, but directly traceable to them. Thus Sir Astley Cooper gives a case of death from an injury to the head two years before. Hoffbauer states that he knew a case in which the fatal injury to the brain was *eleven years* before death. ["Ueber die Kopfverletzungen," 1842, p. 57.] Bullets may remain for more than a quarter of a century in the lung or some other part of the body, and it is quite possible that the ball might be the cause of death even at this remote period. Dr. Taylor states, that amongst medico-legal cases, the *longest* interval at which a conviction has taken place from indirectly fatal consequences, was *nine months.* It was the case of *Regina* v. *Valus,* Devizes Summer Assizes, 1847. The prisoner had maltreated the deceased in September, 1846. After this her health suffered, and she died of phthisis in the following May. The phthisis was recognised in September. On examining the body, two medical men found three fractured ribs, which had evidently not been attended to, and they thought that this probably led to the development of the consumption. The judge left this question to the jury, whether the consumption was caused, or the death of the deceased hastened, by the violence of the prisoner. The jury found him guilty.

Medico-Legal Questions in the Case of Wounds, or other Mechanical Lesions.

Taking the word *wound* in its wide sense of injury, we shall find that these questions in practice are mostly as follows:—

1. What is the nature and extent of the wound or other injury?

In other words, is it an incised, lacerated, contused, punctured, or other wound? Or if any other kind of lesion, what is it?

What is its size [dimensions], *i.e.*, its length, breadth, depth, and its direction?

2. Is this wound or injury mortal? or if there be more than one wound,—

Which of the wounds or injuries do you regard as mortal or dangerous to life—and why?

3. Was this wound [or wounds] inflicted in life?

4. Was the wound or injury (or the wounds, &c.) accidental, or self-inflicted (suicidal), or purposely inflicted by others [homicidal]?

Here we must state *in limine*, that if a man inflicts a mortal wound with intent to rob or commit a felony of any kind, he is guilty of murder, although he may not have meant to kill. Wounds inflicted in self-defence may be held as justifiable homicide, or as manslaughter, according to circumstances.

General Characters and Definitions of Wounds.

An *incised* wound is known in common language as a "cut." Surgeons define it as "a solution of continuity, without loss of substance," and as produced by a weapon (knife, sword, scissors, scythe, reaping or bill-hook, &c.*) with a more or less sharp or thin edge. Mr. Luke, in his lectures, was accustomed to say, that the cutting edge must be the junction of two sides at an angle of less than 90°. Yet we have known the edge of a four-sided or square poker produce very clean wounds. Even the fist, or a blunt body, when it impinges on a sharp bony ridge such as that of the orbit, the zygoma, &c., will often produce a very sharply cut gaping wound. For all practical purposes the wounds produced by broken glass are often *incised* ones. And the edge of a quart pewter-pot often produces similar wounds.

Punctured wounds are caused by the penetration of some pointed weapon, or other substance with a sharp point. A narrow or thin cane, a tobacco pipe, broken glass, scissor points, daggers, penknives, poniards of different kinds, arrows, darts, sharp stones, and the like, may all inflict punctured wounds. They are considered dangerous and troublesome, because the external wound may heal over too soon, and pus be confined; or damage may be inflicted on nerves and blood-vessels in the deeper parts of the wound, the exact amount of which may not at first be easy to determine. A punctured wound may involve some cavity of the body, as the thorax, abdomen, &c. Or worse still, the heart or lungs, or some other important viscus, may be wounded. The authors know of two or three cases of injury to the carotid artery by a tobacco-pipe being driven through the mouth, by violence, whilst the sufferer was smoking. In another case known to them, a clockmaker was picking his ear with the wire stem of a clock pendulum. A drunken man struck him on the elbow, and drove the wire through his ear into the brain. The injury proved fatal.

Contused wounds are those in which there is considerable bruising, and hence there is discoloration of the surrounding skin, from effusion of blood from small ruptured vessels into the surrounding cellular membrane, or areolar tissue [or sub-cutaneous tissue]. To this the name of ecchymosis [from ἐκχύω, to pour out: Mayne derives the word from εκχυμόω, with the same meaning]. The change of colour produced by the oxidation* of the effused blood is popularly known as a *bruise.* About the orbit it is called "a black eye." But after a few hours the dark-blue purple or black discoloration becomes lighter at the edge, and more violet, and from day to day alters its colour, passing through shades of green, yellow, lemon, and other allied colours. Whilst thus changing colour the spot enlarges, but its centre is always the darkest colour. When blood is effused in quantity, as occasionally happens, as for example by the blow of a cricket-ball, such a swelling is called a *hæmatoma* or blood tumour. In the scrotum it is known as a *hæmatocele.* The liquid portions are first absorbed; the blood corpuscles remain longer, eventually even these are absorbed, or the blood may leave behind a network of fibrine, which may become organised into fibrous tissue, with blood crystals (hæmatin, hæmatoidin, &c.) and perhaps fat globules, and cholesterin. *The shape of a bruise is sometimes an important item of evidence.* This has already been mentioned as regards the *marks of fingers* in our chapter on Strangulation. But Starkie ["Law of Evidence," vol. i., art. Circumstantial Evidence] states that on one occasion, in an attempt at murder, the prosecutor hit his assailant, in his own defence, with a house door-key, and the *marks of contusion produced by the wards of this key* on the would-be-murderer's face were the chief means of his identification and conviction. The changes of colour above described seldom commence in less than eighteen to twenty-four hours. Indeed, two or three days may be required before the skin appears discoloured or bruised. The time taken for the completion of these changes of colour, as well as that required for the absorption of the blood, varies from a few days to some weeks. We have known a hæmorrhage in the conjunctiva remain unabsorbed for six weeks, and then disappear in a few hours. We shall return to the question of ecchymosis in the dead body presently.

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* You know that many names are given to surgical knives, as bistouri, scalpel, lancet, tenotome, gorget, &c. Similarly, military weapons of a cutting nature receive numerous designations, as cutlass, claymore, broadsword, battle-axe, javelin, tomahawk, &c., &c.

Lacerated wounds are torn or ragged ones, such as are produced by sawing movements of blunt or jagged instruments, and by repeated hacking at a part. Stones, blunt weapons, glass, earthenware, and similar things, are apt to produce these wounds. So are shots from firearms. They are dangerous from presenting a large absorbing surface, from often containing dirt and foreign bodies (small shot, fragments of wadding and powder, dirt from the streets, &c.), and from the fact that they can only heal by granulation and suppuration, and not by primary union or adhesion.

Many wounds are of a mixed character. This is particularly the case with wounds from firearms. In the use of a knife also, one part of the wound may be cleanly cut or incised, another part hacked or lacerated: and a different direction or force being given to the point of the knife may cause the wound to be a punctured or pointed one at one end.

Poisoned wounds, from weapons properly so-called, are now only met with in barbarous countries, such as the East and West India Islands, New Guinea, &c. The use of the juice of the upas tree (Antiaris toxicaria) in Java, that of the manchineel (Hippomane mancinella), and of other euphorbiaceæ in the West Indies, South America, and Africa; and of animal poisons, such as that of the rattle-snake (Crotalus horridus), and other crotalidæ, although denied by some modern travellers, was undoubtedly common some years ago in many parts of the world, and the Authors have seen such poisonous weapons. The bites of poisonous serpents (of which the adder seems the only one in England), and of animals afflicted with hydrophobia (cats, dogs, badgers, foxes, rats, &c.), must also be included in this category. The *stings* of *wasps*, *bees*, *hornets*, and the like, are also *poisoned punctured wounds.*

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* In some instances the blood-colouring may perhaps combine with sulphur or other elementary bodies instead of oxygen. Essentially, however, the change is one of oxidation.

Of the Danger, or otherwise, of Wounds.

Beck has divided wounds into *slight*, *dangerous*, and *mortal.* This classification is convenient, although a very slight knowledge of surgery will show us that we must not too rigidly adhere to such a definition. No injury is so slight, that it may not cause death, in certain conditions of body, and under certain circumstances. A late almoner of the London Hospital Samaritan Society only scratched his finger with a nail in hanging up a picture, but died from the effects of it in less than seventy-two hours. We have known death to happen from the extraction of a tooth, and from a slight cut of the finger, and from a (self-inflicted) bite in the tongue, in persons of the *hæmorrhagic diathesis.* ["*Hæmophilia.*" Dr. Wickham Legge has given a good account of this diathesis in a little book with this name.] Remembering, however, how serious even a trifling wound may prove, we may yet avail ourselves of this classification.

A slight wound or injury is one then in which there are no parts injured that are important to carrying on life, or any of its functions, and whose uniform course is to heal quickly, and to leave no lesion or deformity behind it. A *dangerous wound* is one which, though not necessarily mortal, is still not exempt from danger, and presents more or less of difficulty in its cure. A *mortal wound* is one whose consequence and effect is death. In this sense only (says Beck) is a wound, in legal medicine, mortal. It may be so in itself, or it may be mortal by accident. Accident or trifling causes may prevent a wound, in itself mortal, from proving so, at least for a time. Thus, as Bohn and Beck mention, a small portion of omentum, or of the fat of the intestine may so place itself in the mouth of a wounded blood-vessel in the abdomen as to prevent a hæmorrhage, which would be fatal but for this obstruction. Thus Bohn (p. 31) mentions a case in which the right iliac artery was found wounded, and life had been prolonged for thirteen days, evidently from this cause. The same author remarks that the precise identity of cases that recover and cases that are fatal cannot be demonstrated; because post-mortem examinations, absent in the cases which recover, continually demonstrate some peculiarities in the fatal cases.*

The wounds which generally prove mortal are—

1st. *Wounds of the heart and of large blood-vessels, such as the Aorta and vena cava;* of the auricles and ventricles of the heart, of the sinuses of the brain, and of the larger blood-vessels in the limbs, head, neck, thorax, and abdomen.[*] Some of those named (in the limbs for instance) admit of ligature, but this presupposes a surgeon in attendance at or soon after the injury.

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* "Dubium an vulnus sanatum exacte idem cum non sanato fuerit." P. 27.

2nd. *Wounds and injuries of the spinal marrow, and especially of the medulla oblongata and upper part of the spinal cord ; of the eighth pair of nerves ;* and of the *solar plexus ;* and severe injuries to the *brain* itself.

3rd. Wounds of some size and depth implicating the *organs of respiration,* such as deep wounds of the *larynx or trachea,* particularly if, in the latter case, the under lip of the wound is retracted inwards so as to form a sort of valve or flap ; wounds of the *pleuræ, lungs,* or *bronchial tubes ;* and wounds of the *diaphragm,* particularly of its muscular portions.

[*] The following arteries are frequently mentioned in these cases of wounds :—

The *Anastomotica Magna* of the brachial.
,, *Anterior* Cerebral
,, ,, Intercostal } Arteries.
,, ,, Spinal
,, *Axillary* Artery (right and left).
,, *Basilar* ,,
,, *Brachial* ,, (right and left).
,, *Bronchial* Arteries ,,
,, *Carotids* (common, internal, and external of both sides).
,, *Cerebellar* Arteries.
,, *Cerebral* ,, (anterior, posterior, and middle of both sides).
,, *Cervical* Arteries.
,, *Circle* of *Willis* at the base of the brain.
,, *Circumflex* of both arms and thighs.
,, *Colica media, dextra,* and *sinistra* of abdomen.
,, *Cœliac Axis.*
,, *Coronary* Arteries of the heart.
,, *Dorsal* ,, of the tongue, penis, foot, scapula, thumb, first finger, and great toe.
,, *Digital* Arteries of the fingers and toes.
,, *Epigastric* ,,
,, *Facial* ,, (right and left).
,, *Femorals,* superficial and deep, of both sides.
,, *Gastric,* gastro-duodenal and gastro-epiploic (right and left).
,, *Gluteal* Arteries of both sides.
,, *Hæmorrhoidal* (external, middle, and superior).
,, *Hepatic* Arteries.
,, *Hypogastric* ,, in the fœtus.
,, *Iliac* ,, (common, internal, and external of both sides).
,, *Ilio-colic* and *Ilio-lumbar* (right and left).
,, *Innominate* Artery.
,, *Intercostal* Arteries (right and left).
,, *Labial* ,,
,, *Lingual* ,,
,, *Laryngeal* ,, (superior and inferior).
,, *Lumbar* ,, of both sides.
,, *Mammary* ,, (internal, right and left).
,, *Maxillary* ,, ,, ,,
,, *Median* ,, (right and left).
,, *Mediastinal* ,, (anterior and posterior).
,, *Meningeal* ,, (chiefly the middle ones).
,, *Mesenteric* ,, (superior and inferior).
,, *Metacarpal* ,, of the hands.
,, *Metatarsal* ,, of the feet.
,, *Nasal* ,,
,, *Nutrient* ,, of most long bones.
,, *Obturator* ,, (right and left).
,, *Occipital* ,,

The *Œsophageal* Artery.
,, *Ophthalmic* Arteries (right and left).
,, *Orbital* ,,
,, *Ovarian* ,, of both sides in females.
,, *Palatine* ,, (ascending, descending, posterior).
,, *Pharyngeal* ,,
,, *Palmar Arches,* deep and superficial, of both sides.
,, *Pancreatic* Arteries.
,, *Perforating* Arteries, of hand, thigh, and foot.
,, *Plantar* ,,
,, *Perinæal* (superficial and transverse).
,, *Peroneal* Arteries in the legs.
,, *Phrenic* ,,
,, *Popliteal* ,, (right and left, in the hams).
,, *Profunda* ,, of arms, neck, and thighs.
,, *Pterygoid* ,, and *Pterygo-palatine* ditto.
,, *Pudic* ,, (deep external, superficial external, and internal).
,, *Pulmonary* Arteries (right and left).
,, *Radial* ,, of the fore-arms.
,, *Ranine* ,, of the tongue.
,, *Recurrent* ,, of arms and legs.
,, *Renal* ,, of both kidneys.
,, *Sacral* ,, of both sides.
,, *Scapular* ,, (right and left).
,, *Sciatic* ,, (right and left).
,, *Spermatic* ,, in the male (*Ovarian* in female).
,, *Spinal* ,, of the backbone.
,, *Splenic* Artery.
,, *Sub-lingual* Arteries } of both sides.
,, *Sub-maxillary* ,,
,, *Subclavian* Arteries, of both sides.
,, *Superficialis volæ* of the thumb (right and left).
,, *Supra-renal* Arteries (right and left).
,, *Tarsal* ,,
,, *Thoracic* ,, (acromial, alar, long, superior, &c.).
,, *Thyroid Axis* of the subclavians (right and left).
,, *Tibial* Arteries (anterior and posterior of both sides).
,, *Tonsillar* Arteries (right and left).
,, *Ulnar* ,, in the fore-arms.
,, *Umbilical* ,, in the fœtus.
,, *Uterine* ,, of the female womb.
,, *Vaginal* ,, in the female.
,, *Vasa intestine tenuis* of the small guts.
,, *Vertebral* Arteries (right and left).
,, *Vesical* ,, (inferior, middle, and superior).

The above is far from a complete list of the arteries, but it includes most of those likely to be named as giving rise to copious hæmorrhage. The aorta, thoracic and abdominal, is not named, because mentioned in the text. For the most part the veins receive names similar to those of the arteries which they accompany.

4th. Wounds of the *digestive organs*, and of the large viscera of the abdomen; to this class belong wounds of the *pharynx, œsophagus, stomach and duodenum, thoracic duct, mesentery or omentum, large or small intestines*, severe wounds of the *liver, spleen*, gall-bladder and pancreas, and of the *bile-ducts.*

5th. Wounds of the *urino-genital* apparatus, if severe; such as injuries to the *kidneys, ureters, bladder, male genitals, urethra* in male and female, *vagina, uterus and ovaries*, in the female.

6th. Extensive gun-shot or other injuries in which the ball or other missile takes a long and circuitous course, and fractures one or more bones, with considerable damage to soft parts.

The wounds which are fairly reckoned dangerous are very properly divided by Beck (*loc. cit.*, pp. 612-13), into two classes. The first class consists of those which are *dangerous to the integrity of the functions of the parts wounded*, or of parts contiguous to or related to these without being necessarily mortal. In this class are such wounds as may *destroy the sight* of the eye, or of both eyes; or affect the *secretion of tears;* wounds affecting the other organs of sense, as the nose, mouth, ears, &c. *Wounds dividing nerves*, so as to destroy the *motor* or *sensory* powers of the parts supplied by their nerves; *wounds of the generative organs*, not severe enough to destroy life, but impairing or destroying the reproductive powers, or impeding the act of coitus; wounds or injuries producing sinuses or fistulous openings, into cavities or natural channels (*fistulæ in perineo, f. in ano*, vesico-vaginal, or utero-vesical fistulæ, &c., &c.); wounds of the abdominal muscles, predisposing to ventral herniæ; all wounds producing great disfigurement; fractures of the clavicle and sternum, and depression of the xiphoid cartilage; as tending to impair respiration.

In the *second class* of *dangerous wounds*, are *such wounds and injuries as, though not mortal in themselves, often prove fatal;* and in which, on this account, a guarded prognosis is always necessary. In this are included (1st) all *penetrating and punctured wounds*, although there may be no dangerous symptoms at first; especially those of cavities and joints. (2nd) All *lacerated* and *contused wounds*, whether of head, chest, or abdomen, or *extremities.* (3rd) All compound *fractures and dislocations* (or luxations, as they are sometimes called); particularly if the injury be at or near a joint, and if many nerves and blood-vessels be implicated. On this account, the hands and feet and the knees are reckoned dangerous parts to wound. Wounds of nerves and tendons are supposed to be particularly obnoxious to *tetanus.* [Surgical writers state, that although tetanus, or locked-jaw, &c., may be caused by wounds and external injuries of every description, it is especially common after lacerated and punctured wounds of the hands and feet; after gunshot wounds, compound fractures, compound dislocation of the thumbs, and wounds irritated by foreign matters, or in which nerves are exposed. Mr. Morgan (quoted by Dr. Druitt) knew it even caused by a blow with a school-master's ferule, but it is very rarely caused by clean, simple incisions. It may come on very quickly, but the most common period is when the wound is nearly healed].

On the other hand, we may consider as *slight* wounds or injuries, in themselves of little danger, and not likely to produce permanent injury or deformity in healthy constitutions, and under favourable circumstances, with proper treatment:—(1st) All simple fractures or dislocations: *see* page 714. (2nd) Wounds of skin and muscles in which the division is clean, and in the direction of their fibres, and where no tendon or aponeurosis, no large nerves or blood-vessels of any magnitude are injured; and in which there has been no severe shock to the system. Such wounds, in good constitutions, heal up with no deformity beyond a slight linear cicatrix, which may soon disappear, and no inconvenience or loss of function results.

Yet not only Beck, but all ancient and modern writers of eminence, are forced to confess that these distinctions are in great part arbitrary—and are constantly modified in actual life by circumstances of age, sex, constitution, previous diseases, temperament, &c.; so that (as remarked above) the slightest scratch or injury may prove mortal, and (by timely surgical aid, or by some favourable circumstance, as great vigour of constitution, the timely formation of a coagulum and the like), some of the wounds reckoned as mortal, and many of those reckoned dangerous, may be recovered from, with comparatively little permanent deformity or damage. Not a few old soldiers carry bullets in their head, chest, abdomen, or limbs, and seem little the worse for them. *These happy terminations of severe and usually mortal lesions need not be insisted upon here, as the skill of the medical attendant, or the good constitution or favourable surroundings of the sufferer, do not enter into the calculations of the murderer or assailant.* If we go further, and admit a special intervention of Providence in some special instances, this is still less likely to form a portion of the schemes of the criminal. We cannot, however, pass so lightly over the circumstances which tend to enhance the danger of slight wounds, and to render dangerous wounds mortal. To explain them fully would be to write a gigantic treatise, but we may briefly indicate a few of the more common ones. In so doing, we must confess our obligations to nearly all the systematic writers on surgery—but more particularly to Sir James Paget's written cautions, and the verbal utterances of Mr. Spencer Wells, and Mr. Jonathan Hutchinson. Beck has classified them under four divisions (p. 613 to 624). We shall take these in a somewhat inverted order.

1st. Wounds or other injuries may be rendered more than usually fatal by the ignorance or negligence of the surgeons or medical attendants, or of the nurses, friends, relations, or bystanders. The practice of our own courts and of the old Roman and French laws, has been to allow the criminal an undue advantage on this point. Thus the *Lex Aquilia* [quoted by Beck] declared "Si verberatus fuerit servus, non mortifere, negligentiâ autem perierit, de vulnerato actio erit, non de occiso;" and Foderé (vol. iii., pp. 290, 291), says that if negligence or bad treatment was proved, it freed the individual, unless premeditated design was established. We do not wish to be understood that a criminal should be held guilty of *murder*, when the original injury inflicted by him was slight; but we think the substitution of *manslaughter* the very utmost concession that is fairly demanded, unless he who inflicts the injury should himself do the utmost possible to secure the safety of his victim. For consider:—If a man hangs another, and death do not result from the first fall, life and death will (humanly speaking) depend, first, on whether the rope be or be not cut away within a few seconds or minutes from the neck, by some one arriving in good time; and, secondly, on the skilful treatment of the hanged person when cut down. But what would-be-murderer or actual hangman ever thought for a moment of these two things? Or, take another illustration:—In a duel with pistols, a little tremor in the duellist's hand, a little extra powder in the charge, the direction of the wind, or the presence of a pocket-book, or of some other book, in the pocket of the man shot, may cause the bullet, though well-aimed, to just escape a vital part, such as the heart. But, is the challenger more guilty of the death of the challenged because the latter had no book or other substance to divert the missile, or because there was no breeze, or fault in the loading of the weapon, to cause the projectile to miss? What would-be-murderer ever took precautions that his victim might have the highest surgical skill, like that of a Larrey, a Dupuytren, or a Brodie? If we come to nurses and friends, we shall see the absurdity of expecting them to possess any great amount of anatomical, medical, and surgical skill. And in the case of medical men, the Lord Chief Justice, Sir Alexander Cockburn, expressly declared in the case of *Simpson* v. *Davey* [referred to at p. 720, on Malapraxis], in his charge to the jury, "a patient is not entitled to expect the highest possible medical skill and knowledge in his medical attendant; all he can legally demand, is a fair and competent average skill and knowledge—that his medical man should know what all properly educated medical men ought to know of their profession, and that he should apply that ordinary and average knowledge and skill to the treatment of the particular case." Lord Denman, Chief Justices Kelly, Park, and others, have expressed themselves in similar terms on many occasions. If then we consider the case of a man wounded, perhaps at night, either in the country or in some great city, where perhaps he may be a stranger, we must see at once that it is absurd to expect that the first comer who finds him, who may be an unlettered labourer, or male or female servant, should possess medical knowledge, or even general knowledge of any high order. For this reason our opinion is, that but little weight should be given to the question of skill, or no skill, or knowledge or ignorance on the part of any attendants on the wounded, whether medical or otherwise. As this involves the question of *Malapraxis*, it is right to observe, whilst referring you to that section for other matters, that considerable differences of opinion exist (from want of sufficient *science* or real knowledge on the part of the whole medical profession) on the following points:—On the treatment of some wounds [and especially of amputations, gun-shot wounds, and fractures], as to *primary* or *secondary amputations;* the expediency of *trephining or trepanning* in some injuries to the head and spinal cord; on the open-air or *anti-septic* treatment of wounds; on the causes and treatment of *pyæmia*; on the question of what is called *hospitalism*, or the propriety of permanent hospitals, and the causes of excessive mortality; on the question of early or late *search for bullets* or other projectiles; on the respective merits of amputation and excision of joints in certain cases; on the relative danger of different anæsthetics, such as ether and chloroform; on the treatment of traumatic delirium and delirium-tremens; on the best methods of dealing with wounded arteries in certain contingencies; as to the necessity and usefulness of narcotics and alcoholic stimulants in certain diseases; the respective merits and demerits of craniotomy or the Cæsarian section in some cases; on the propriety of using the forceps early in obstetric cases; the respective merits and demerits of lithotomy and lithotrity in certain cases of stone in the bladder; the propriety of paracentesis (by aspirator or otherwise) in certain internal diseases, as empyæma, dropsy, &c.; the best treatment for some cases of burns and acute rheumatism; the propriety of venæsection in apoplexy, and some acute diseases, and in cardiac disease; and as to the use of mercury in *secondary* syphilis, and in some skin diseases *; the propriety of ligaturing veins, of excising and suturing nerves; as to the best treatment of gangrenous intestine in cases of strangulated hernia; and the best methods of dealing with large fibroids of the uterus; and extra-uterine fœtations—each and all of these, and a few other things, are still legitimate grounds of difference of opinion, and consequently of treatment, even amongst well-informed members of the profession. *Quot homines, tot sententiæ* is an old maxim which applies to them all. In scientific matters, however (as probably in theology also), differences of opinion mean imperfection of knowledge. Medicine (including surgery) is still in great part an *art* rather than a *science.* As our knowledge widens and deepens our differences will decrease. What concerns us and the public as to these matters is, that whilst it would be unfair to charge a prisoner with the results of really improper and unskilful treatment, it is equally unfair that he should benefit from the results of matters of skill or the reverse, of which he took no thought when he committed the assault and inflicted the wound. I might wear armour round my neck or chest, which might be proof against a knife or a bullet; but my assailant might, and probably would be, totally ignorant of this defence of mine. He must therefore be judged by the force and direction of the blow, the situation and character of the wound, and not by its results merely.

2nd. The *season of the year*, the nature of the climate, the insalubrity or the reverse of the place where the injury was inflicted, the prevailing winds and weather, the scarcity or abundance of food and of so-called medical comforts, and a sufficient or insufficient supply of certain medicines and surgical appliances, may all tend to the recovery, or fatality, or tedious convalescence, or permanent damage from wounds, and other injuries. We may quote, as examples, that *tetanus* is more common in hot countries, and *gangrene* in cold, damp weather, such as Baron Larrey mentions after the battle of Eylau, and in the retreat from Moscow; and gangrene, pyæmia, and erysipelas, in overcrowded hospitals, old hospitals, and in badly-ventilated dwellings and wards; *fever*, especially typhus (of which the *plague* is one form), is often very prevalent in camps, gaols, poor quarters of large towns, and in besieged cities. Metzger (p. 376) and Mahon (p. 25, vol. ii.), both quoted by Beck, mention the dangerousness of the old *Hôtel-Dieu* Hospital, &c., in cases of trephining: "Dans certains hôpitaux, et notamment à l'Hôtel-Dieu de Paris, le trépan est presque toujours mortel." Egypt is notorious for bad forms of ophthalmia, often ending in blindness; whilst, according to Bohn, Sebezius, Foderé, and others (quoted by Beck), some parts of the Mediterranean coasts appear specially favourable to wounds of the head. Missionaries from the South Sea Islands have testified to the marvellous rapidity of cure of severe spear and arrow wounds in some of these islands. In the judgment of the Authors these special circumstances (unless the special fatality of a special place could be proved to be known by a prisoner) should not be allowed in any way to influence the sentence on the prisoner, or to modify our judgment of the true character of the wound or other injury. The same may be said in general terms of the choice of a weapon, except that, here, the more deadly and certain the weapon the more likely is it that murder was intended. This is, however, scarcely a medical question, except so far as the dangerousness of the wounds is concerned. As we have said before, gun-shot and other penetrating and punctured and lacerated or contused wounds are more dangerous, *cæteris paribus,* than clean incisions.

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* Until very lately the profession were far from unanimous as to the use of mercury in *primary* syphilis. Now, however, we believe that nearly all whose opnions are of any weight in the profession, admit that the use of mercury is generally desirable in cases of true infecting chancres.

3rd. *The ignorance, obstinacy, or excitability, and other passions of the injured man, may affect the issue of the wound.* In other words, a slight wound may be rendered dangerous, and a dangerous wound mortal, by the conduct of the patient. A man may (and often does) become delirious after a gunshot wound; in his delirium he tears off bandages, or tears away the ligature from an artery, and dies of hæmorrhage. Or he eats and drinks improper food and beverages, does not take the medicine, or submit to the regimen prescribed. Or his rage and passion, if a violent man, increase the original mischief, prevent sleep, &c. Here we must distinguish between what is done in delirium really arising from the injury (as in wounds of the head, &c.); and other acts, depending on natural character, or wilful neglect of surgical or medical advice; if we are to apportion the blame aright. But, once more, we ask,—What assassin, garrotter, rioter, burglar, or criminal of any kind who violently assaults another, ever takes care to assure himself that his victim is a man of firm and temperate mind, clear-headed, cool, rational, and sober, both in mind and habits? Perhaps none at all. Few, even of the victims, are careful, like Shakspeare's hero, only to be drunk "in honest, civil, godly company!"* Why then should these circumstances affect a verdict? Let justice look at the intention and direction of the wound, not at the character or conduct of the victim. The veriest sot and most abandoned prostitute are equally entitled with the sober citizen and chaste citizeness to have their lives and persons protected.

4th. *The age and constitution of the patient, his previous diseases, and the prevalent epidemics may, and often do, affect the issue of wounds* and other injuries, and that perhaps more than any other of the causes we have named before. As regards (1) *age*, it is well-known that *very young children bear the loss of blood badly. The nervous system is also very susceptible in early life.* Convulsions of a tetanic type, as well as clonic spasms, being very common in infancy. In very advanced life there is frequently a return to the infantile condition. On the other hand, both children and very old persons, if they survive the immediate shock of an assault or accident, often show marvellous powers of recovery. The Authors have known men and women, over seventy years of age, burnt so severely as to necessitate amputation at the shoulder or the knee, whilst it was difficult to get skin enough to cover the flaps, and yet they have made a good recovery. Most of the successful amputations at the hip-joint they know have been in quite young subjects. Lithotomy, again, is almost uniformly successful in young children, and almost as uniformly fatal in very old people; but here the condition of the kidneys is probably the explanation of the discrepancy. On this point of age we must refer you to our articles on Malapraxis [page 712], and on Survivorship [page 613.]

There may be (2) what are called *idiosyncrasies, or personal peculiarities on the part of the patient,* either congenital or acquired, which may greatly affect the issue of wounds and other injuries. Amongst such we may reckon—

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* "Merry Wives of Windsor," Act I., Scene 1.

(*a*) *Transposition of viscera*, sometimes called *ectopia.*[*] A young man, son of a fellow-student of the Authors, had his heart on the right side. The liver was transposed, and occupied the left hypochondrium chiefly. He informed us that more than one medical man had proposed to tap this liver-dulness for an empyæma! It is fair to British practitioners to say that these gentlemen did not reside in the United Kingdom.

(*β*) There may be an *irregular distribution of blood-vessels.* Some of these occur with tolerable frequency, and are familiar to most surgeons. Thus, the brachial artery may divide very high up into two large vessels. Again, the obturator artery is usually said to arise from the anterior trunk of the internal iliac, but frequently does so from the posterior. *Gray* remarks ("Anatomy," p. 393) "that in two out of every three cases the obturator arises from the internal iliac; in one case in three and a half, from the epigastric; and in about one in seventy-two cases, by two roots from both vessels. When it takes a course *inwards*, along the free margin of Gimbernat's ligament, it would almost completely encircle the neck of a hernial sac (supposing a hernia to exist in such a case), and would be in great danger of being wounded if an operation was performed." Again, a very large number of persons have the radial pulses at the wrist (commonly called *the pulse*) unequal on the two sides; so that, for instance, the right pulse may be almost imperceptible, whilst the left is of good volume, owing to an irregular distribution of the radial artery. *In all medico-legal or important cases, feel both pulses.* An account of many other varieties in the distribution of arteries will be found in Harrison's "Surgical Anatomy of the Arteries of the Human Body," Dublin, 1824. *See* also Quain's "Anatomy of the Arteries," &c., London, 1844; and the works of Hyrtl, Cloquet, Cruvelhier, Quain, Ellis, Struthers, Theile's "Traité de Myologie et d'Angiologie," and the "Encyclopédie Anatomique," Paris, 1843, &c.

(*γ*) *The wounded man may suffer from hernia;* and a kick in the groin, which would only be painful to you or me, might produce fatal peritonitis in such a patient.

(*δ*) Or he may have an *unsuspected aneurism*, and a very slight degree of violence may rupture it and cause death.[†]

(*ε*) *The bones of the skull may be excessively thin*, unusually so; or the bones may be defective altogether, as in the cases quoted by Beck in a foot-note to his 613th page. *See* also a notice of Casper's and Tardieu's cases in young infants, in our chapter on Infanticide, p. 803. *Or the bones may be unusually brittle.* [*See* our remarks, p. 876.]

(*ζ*) *The wounded person may be what is called a "bleeder,"* in other words a sufferer from the hæmorrhagic diathesis of which we spoke before at p. 1049. Beck has collected numerous cases in foot-notes to pp. 614, 615 of his work. Many more will be found in Dr. Wickham Legge's work called "Hæmophilia" [Lewis, 1875]. The Authors have met with many instances of this. A patient of the late Mr. John Adams at the London Hospital nearly lost his life, owing to the profuse hæmorrhage, after his former medical attendant had excised a metacarpal bone. A gentleman, known to one of the Authors, lost his life from the extraction of a tooth, for the same reason. In a recent case, under the care of Mr. Savory, a boy bit his tongue, and had severe and almost fatal hæmorrhage as much as a fortnight after.

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[*] In the "London Medical Record," Oct. 16, 1876, p. 447, there is an abstract of a paper of Burgl on this subject, from the Munich "*Aerztliches* Intelligenz-Blatt," Nos. 24 and 25, 1876, containing a tolerable Bibliography. See also the "London Medical Record," Sept, 15, 1875, for cases by Dr. Scheale, with references to many others.

[†] "Aneurism," or "aneurysm" (from 'Ανευρύνω, to enlarge), a swelling or tumour filled with blood (fluid or solid), arising from the rupture, wound, ulceration, or simple dilatation of an artery. Unless *traumatic* (*i.e.*, from a wound), this presupposes a diseased or degenerated condition of the coats of the artery. Erichsen's "Surgery," and Holmes' "System of Surgery" both contain exceedingly good accounts of this affection; but no book on Medicine or Surgery now-a-days omits it.

(η) There may be *disease of the organs of circulation.* Heart disease increases the risk of death from shock and syncope, and taken with *degeneration* (fatty, atheromatous, and calcareous) *of the arteries,* vastly increases the dangers from Gangrene, and Embolism. If the *veins* are *varicose,* or otherwise diseased, we get great risk of death from hæmorrhage (often sudden), from phlebitis, and from pyæmia, erysipelas, thrombosis, embolism, &c.* Rindfleisch and others have recently shown that "apoplexies" and hæmorrhages often result from embolisms or pluggings, and these again from diseased conditions of the heart, blood-vessels, or blood itself.

(θ) Next to disease of the heart and large blood-vessels, if indeed it be not more fatal, is *disease of the kidneys.* This (as in the case of the Emperor Napoleon III.) may even affect the fate of vast armies, and of an entire empire. But to descend from vast numbers to individuals. *Albuminuria,* or *Bright's disease* of the kidneys (which is really a general disease of the whole system), is one of the commonest causes of death after operations; and for the same reason, of death after wounds and other injuries. This is probably the true reason why *gouty* patients fare badly under similar circumstances.

Although not truly a kidney disease, being in fact rather a symptom than a disease in itself, *Diabetes mellitus* [and perhaps diabetes insipidus also] may be conveniently mentioned here, as a condition very unfavourable to recovery from injuries of any kind. Note too that carbuncles and cataracts are often associated with diabetes, or at all events with glycosuria; that is, the presence of sugar, in abnormal quantities, in the urine.

(ι) *Diseases of the respiratory organs,* and notably *pulmonary phthisis,* tend to hinder the healing of wounds, and the recovery from operations (as for example, fistula in ano, if operated on in the later stages of phthisis, will sometimes not heal at all). On the other hand, it is fair to say that the Authors have seen many fractures repaired in the usual time when there has been advanced disease of the lungs; and the same is true of many wounds.

(κ) *Disease of the bones* (osseous system) is, of course, very unfavourable to recovery from accidents and injuries. This is particularly the case where there is dead-bone, or where joints, especially large ones, are implicated. In this case the lungs are very apt to be involved. And pyæmic abscesses form in the liver, lungs, spleen, heart, and other joints than those first affected. This is more particularly the case when either of the two following conditions are present :—

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* *Varicose veins* in the leg are common in old men and women; and the Authors have known several deaths from brutal *kickings* on such varices having caused fatal hæmorrhage. This condition of veins is often congenital, and is one of the things for which recruits are often rejected.

(λ) We need scarcely say that *syphilis is one of the most unfavourable general conditions possible.* As for example, if a patient with constitutional syphilis is attacked with pneumonia he seldom recovers. Again, in children, or others, with inherited syphilis, plastic operations constantly fail; and the most trifling injuries lead to protracted discharges, and the most serious results: dead bone, abscesses, ulcers, and even death, not being uncommon.

(μ) What surgeons call *scrofula is probably a mixed condition;* or rather this name is used to include the tubercular diathesis (or hereditary predisposition to tuberculosis), hereditary syphilis, and a mixed condition, probably made up of a variety of inherited proclivities; a chief characteristic of which (according to Mr. Hutchinson) is *that the flesh heals badly*, that *the lymphatic glands are very prone to disease,* and that caries and necrosis of the bones, and diseases of joints, leading to entire or partial destruction of the synovial membranes, cartilages, and other constituents of joints, are common after apparently trivial injuries. These affections lead to deformity from the ugly scars in the neck, face, limbs, &c., to anchylosed joints, or loss of limbs, to spinal curvatures, and in not a few cases to death.

(ν) *Diseases of the chylo-poietic viscera*, in other words of the stomach, bowels, and intestines, must, *primâ facie*, render the recovery from accidents and wounds of various kinds tedious, uncertain, or impossible. As yet, however, with the exception perhaps of *dysentery* and *diarrhœa*, in the case of wounded soldiers and travellers, not much is known of these relations.

(ξ) *Zymotic diseases* (*typhus*, and its severe form the *plague*, *small-pox*, *typhoid fever*, *measles*, *and intermittent fevers* of various kinds, including *relapsing fever*), are often the scourge of camps, and have over and over again killed more victims than all the complicated engines of war. What is called *surgical* fever or traumatic fever, which is of two kinds, primary and secondary [*see* Billroth's "Principles of Surgery"] is quite distinct from, though it may be combined with, any one of these, or other similar diseases. This distinction was drawn by Bohn[*] (p. 83 of his "De Renunciatione Vulnerum, seu vulnerum Lethalium Examen") of Amsterdam in 1732. One of the cases given by Zacchias shows the difficulties that may thus arise. Whilst the plague raged at Rome one Ansovini received in a quarrel a wound on the head, which bared the bone, but did not break it. By the help of two friends he retired from the strife, and one of these friends continued to visit him, but died four days after of the plague. For three days the wound looked well, but after that fever came on with headache, bilious vomiting, and violent inflammation of the wounded part. On the fourth day the wound was gangrenous, and he had petechiæ (purple spots) and buboes; and on the sixth day he died. The inflicter of the wound was arrested by the minister of justice on the ground that it was the cause of death, or that at least it predisposed the man to the attack of the plague. Zacchias, consulted by the friends of the accused, decided that the wound had not been the cause of death, because there were no symptoms immediately after its infliction that indicated a mortal injury to the head; that the appearances which supervened were too rapid in their progress to appertain to it (*i.e.*, the wound), and evidently belonged to the plague; and it was manifest he had taken this disease from his friend. Finally, two diseases were present together, and the ordinary course of one (the plague) was fatal, whilst that of the other is usually to proceed to a favourable termination. It was certainly proper to assign the death to the former [consilium, No. 74]. Although in the main this decision was just, yet the experience of most medical men who see many injuries to the head agrees with the dictum of *Abercrombie* and *Liston*, that no injury to the head is so trivial as to be despised, or so severe as to be despaired of, "excepting, of course, those cases immediately fatal, or when death is plainly inevitable from the first." And, again, it must be noted that a wound offers facilities of absorption for all kinds of contagious and infectious matters. As regards absorption in general, our knowledge is greatly increased since the time of Zacchias. To make this circumstance clear, as to the effect of wounds, take this illustration:—You may lay vaccine virus on the skin of an infant, so long as there is no abrasion, *i.e.*, so long as the skin is entire, without any effect. Just slightly scratch or abrade the cuticle [or scarf skin or epidermis], and the result is that the child is vaccinated, or gets the cow pock. And if we study cases of erysipelas we shall find that in ninety-nine cases out of a hundred there is some wound, scratch, or sore place, more or less raw, from which, even facial or so-called medical erysipelas, takes its starting-point. These sore places are often inside the mouth or nostrils, or under the hair, but a careful search discovers them in the vast majority of cases. What is called *Hunter's law* by some—that one severe disease excludes another—is only partially true, and, besides this, scarcely affects our point, which is, that wounds not necessarily mortal, or even very dangerous, may be rendered so by the prevalence of contagious diseases. This is the place to remark that Beck seems to draw a distinction between traumatic and idiopathic erysipelas, which is by no means generally admitted now-a-days. We refer to his statement as to the way in which erysipelas commences.

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[*] "Alia ex vulnere ipso, ut tali, hanc à parte læsa immediate emergant; alia alium extra vulnus causam agnoscant; alia indifferenter se habeant, id est, modo à vulnere, modo aliunde eveniant: probe omnes ac singulæ ponderandæ sunt in vulnerato circumstantiæ, et ex harum demum collatione, cujus generis sint illa individui presentis, prudenter inferendum."

(*o*) *Intemperate habits on the part of the wounded* or injured person are a frequent cause of death from apparently slight injuries. Beck cites a number of cases, but the records of our police-courts and hospitals will furnish us with an almost unlimited number of similar cases. A man and his wife quarrel—perhaps both are drunk—one gets the upper hand, or as the phrase is, the best of it; and either strikes the other a heavy blow, or knocks him, or her, down. Such a blow, in a temperate person might do little permanent damage; in the case of a drunkard, or habitual sot, the effect is to rupture some large blood-vessel, very likely one in the brain, and the injured person either dies on the spot, or very soon after. Now, as the principle of English law is, that drunkenness is no excuse for any act committed in this state, it might be said that it is not fair to attribute the results of drunkenness to the striker of the blow. In reality, however, we shall find that habits of intemperance are so exceedingly common—intemperance, we say, by which we mean the habitual excessive use of alcoholic stimulants, that we cannot fairly hold that ignorance of the effects exculpates the person who struck the blow. If I set fire to a single house, the conflagration may extend to a whole city. This would be far more likely to occur in a city like Chicago, mainly built of wood, or with wooden shingles instead of tiles to the roofs. Yet we suppose few would say that the preponderance of wood in such a case was an excuse for the incendiary. Rather the reverse. However, these are not matters of opinion merely, either ours or yours, for the dictum of Lord Hale will apply to this, as to most of the conditions we have just been describing.

"It is sufficient," said he, "to prove that the death of the party was *accelerated* by the malicious act of the prisoner, although the former laboured under a *mortal* disease at the time of the accident."

This, says Dr. Guy, applies to cases of very young, feeble, or aged persons, and *pregnant women*—as well as to the other cases above-mentioned. We may pause for one moment here, to consider some *medico-legal relations of pregnancy* omitted in our chapter on this subject. First, as regards epidemic diseases (smallpox, typhus, &c.), it would appear that pregnant women are somewhat protected by their condition, but that the loss of blood, and the detachment of the placenta from the walls of the uterus, leaving open sinuses (only closed by perfect contraction of that organ) which occur in delivery, whether at full term or before, are favourable to the absorption of the contagion, and of animal poisons in general. So that a woman recently delivered is more than usually exposed to danger. The majority of such cases probably die, the difficulty being to separate these cases from those of "puerperal" fever—as in almost all of them there is peritonitis. Next, pregnant women are liable to *abort* as a result of comparatively slight injuries. We have seen, when speaking of criminal abortion, that some women may be almost killed, and yet no separation of the ovum take place, and no abortion or premature labour set in. In others, on the contrary, the mere excitement of a quarrel is sufficient to bring about a miscarriage or untimely birth. This, in itself, may be dangerous, from the mental shock, from the loss of blood, and other causes; but still more so by opening the way to contagion from erysipelas and other contagious diseases. It would seem that erysipelas and a low form of puerperal peritonitis were almost convertible terms in some cases [*see* Watson's "Lectures on Physic"]. Pregnant women again are very subject to convulsions (especially if they have any kidney mischief), which may be fatal; and to pyæmia, and broncho-pneumonia of embolic or thrombotic type. Gangrene is sometimes a result of the plugging due to this excess of fibrin in the blood. We have known several women die of acute gangrene of the lower extremity. We have thus indicated that the pregnant condition, though not in itself a disease, yet renders the woman liable to severe and dangerous consequences if any act of violence should cause premature expulsion of the ovum or fœtus.

Having thus dwelt upon some of the complications and peculiarities which may alter the character of wounds, we must refer for a short time to the ordinary appearances presented by—

Wounds inflicted on the Living, their Appearances and Results.

I. *Incised wounds, inflicted on the living* with sharp, clean instruments, present the following characters:—(1st) There will be evidence of more or less bleeding, and this blood will generally be of an arterial character, and will be found to have clotted or coagulated where it has fallen on other parts of the body, on the clothes, floor, or on surrounding articles. The splashes or spots of blood from an artery will generally be found (as stated in the chapter on blood-stains) of a comet-like form, something like a note of exclamation —• or •—•. [Dr. Taylor gives a figure of some blood-spots on bricks, p. 535, vol. ii.]* If the wound have not been cleansed or wiped, or otherwise interfered with, there will be clots adhering to the edges, or to wounded vessels. (2nd) The *wound gapes, and its edges are everted* [turned outwards]. This is due to the vital elasticity of the skin, and to its own muscles. (3rd) The muscular and cellular tissues of the wound are deeply reddened by the effused blood. Dr. Taylor correctly states that even when no blood-vessel of any importance is wounded, and no blood is found on the wound, the gaping everted edges and retracted muscles will often prove the wound to have been inflicted during life. In a case of child-murder [*Elphick*, March, 1848], Mr. Prince was able, by this criterion, to state that the wounds on the child were inflicted during life. The mother afterwards confessed the truth of this. (4th) As minor characters, in severe wounds, may be mentioned the contraction and retraction of arteries. This, however, occurs so long as the tissues have any life. *See* our remarks on wounds inflicted after death.

If the wound have been inflicted some days, it may exhibit either signs of repair or signs of destruction or death of tissues. As regards the repair of clean-cut wounds we must remind you that several modes of repair are possible. (*a*) As first, if the parts be very accurately brought together, wounds, and particularly small clean ones of no great depth, may grow together at once—by coalescing, without the intervention of blood, or lymph, or pus. This is the "*union by first intention*" of Hunter. Some surgeons call it *simple adhesion* or *coalescence.* John Hunter thought that blood formed the bond of union, but Dr. Macartney has shown that this is not so, and gave the name of *immediate union.* Sir James Paget mentions a case of amputation of the breast, in which there was such perfect union that on the patient dying of erysipelas three weeks after, it was impossible to say, even with the help of the microscope, that there had been any inflammation or any exudation of matter. (*b*) In the lower animals, and sometimes, though rarely, in human beings, a similar *perfect adhesion takes place under cover of a scab or crust* of dried hair, blood, &c., which forms an air-tight covering. Surgeons now imitate this by the use of

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* Counsel sometimes press the question on the medical witnesses, "Will you swear that it is *arterial* blood ?" It is therefore well again to state that blood from a vein or from capillary vessels, after it has been exposed to the air, as when it flows slowly, acquires the character of arterial blood, more or less completely, as, for example, the colour becomes bright. It also happens, though rarely, that muscular pressure will cause blood to spurt from a vein. Yet in general the question is an easy one to answer, as there is usually little difficulty in distinguishing arterial from venous blood by the characters in the table here given :—

Arterial Blood.	*Venous Blood.*
1. Bright red.	1. Dark purplish red, almost black.
2. Comes in spurts or jets, which correspond to the cardiac systole.	2. Trickles or flows more slowly, or in gushes from very big veins not much affected by cardiac action.
3. Hardly any dichroism.	3. Dichroism well marked.
4. Coagulates quickly in health.	4. Coagulates slowly.
5. Spectrum of oxyhæmoglobin.	5. Spectrum of reduced or deoxidised hæmoglobin.

Other characters, depending on chemical analysis, are given in physiological manuals. They are not of practical moment here.

lint dipped in blood, or "styptic colloid," or some other kind of collodion, or by some modification of Lister's antiseptic dressings. *Subcutaneous wounds*, as in tenotomy, repair in a somewhat similar way. The "nucleated blastema" which forms the reparative material, not being considered an inflammatory product. (*c*) What is now commonly called "*union by the first intention*," or by *adhesive inflammation* ["*primary adhesion*" of Sir James Paget], consists in the union of parts by means of *plastic lymph*, or the fibrin of the liquor sanguinis—*chair coulante* of the French. The wound first becomes glazed by this liquid flesh, then besides the fibrin in solution some leucocytes are found, and probably the nuclei of connective tissue. These become organised into fibro-nucleated tissue, which soon becomes vascular, and after a while, even nerve tubules shoot into it. To secure this mode of union, all bleeding must have ceased, and there must be no clot between the opposed surfaces. Hence, in amputations, the flaps are sometimes not united by sutures or otherwise, until some hours have elapsed, so as to secure complete absence of hæmorrhage. It is generally admitted by surgeons that a certain amount of inflammation* is necessary to secure this mode of union—if this inflammation go too far, we get either suppuration or some of the destructive changes to which we shall presently recur. (*d*) *Union by granulation*, which involves *suppuration*, is the common method in wounds exposed to the air, when there is much disturbance of parts, or where anything interferes with repair. Surgeons call this *union by the second intention*, and it has been subdivided into union by granulation proper, and the adhesion of granulating surfaces, which is called "secondary adhesion." In this mode of repair the *granulations* called "proud flesh," when excessive, are really lymph, covered with pus, or leucocytes. The microscope shows them to be composed of cells, heaped up without much order, and connected by but little intermediate substance. When single they are colourless, when in clusters they become ruddy. Blood-vessels form in them, and gradually they become organised into fibres, &c., and into a tissue bearing an external likeness to that of the wounded part, whether skin, flesh, bone, cartilage, &c. In reality, however, a *cicatrix*, whether in the skin or elsewhere, contains more fibres than the tissue it replaces, is less vascular, and has a lower vitality. A figure of granulations may be found in Hughes Bennett's "Principles and Practice of Medicine," p. 168; this figure shows three capillary loops of new blood-vessels forming in the vertical section of a granulating sore; and in Miller's "Principles of Surgery," pp. 200 and 201, this is from a drawing of Dr. W. T. Gairdner's, and well shows the new capillaries, the fusiform cells, and the leucocytes or pus-cells. [Besides the works quoted here and in the last foot-note, consult Erichsen's, Pirrie's, Druitt's and Bryant's "Manual of Surgery,"—Sir James Paget's "Lectures on Surgical Pathology," Billroth's "Surgical Pathology," and Rindfleisch's "Pathological Histology." The English translation of the latter by Dr. Baxter also contains a good diagram of a granulating surface in process of repair, vol. i., p. 126, × 300 diameters]. There has been much discussion as to the origin of the pus-cells or matter covering wounds in the granulating stage—whether these pus-cells [which are more or less spherical, with rough surfaces, revealing three or more nuclei, with nucleoli when treated with acetic acid and some other reagents, and varying in size from $\frac{1}{1500}$, or even larger, to $\frac{1}{2000}$ of an inch in diameter], whether they are only the leucocytes or white corpuscles of the blood, or whether they are formed from the pre-existing elements of the tissues, or new formations altogether; the matter appears of small importance, if any, in a medico-legal aspect. A surgeon is, however, sometimes asked if the pus on a sore be "healthy" or "laudable" pus or not? You know that pus, to deserve this name, should be moderately thick, yellowish, free from offensive odour when fresh, and not mixed with shreds of any kind. Under the microscope the little bodies described above should be seen. These should roll freely over one another. When shaken up with water they soon subside, forming a sort of creamy layer at the bottom. Unhealthy pus is either very thin or clotted and grumous—has an offensive odour, contains shreds and patches of dead or dying tissue; and under the microscope the corpuscles are either badly formed and disintegrating, or their place is more or less entirely taken up by jagged bodies, and granular or molecular matter, consisting of the *débris* of tissues, with fat cells, and "exudation corpuscles" or "compound granule cells," with vibrios and bacteria or bacterioids, perhaps in lively movement, or fungus sporules, &c. There may also be an admixture of blood. To sum up so far, wounds undergoing healthy repair may exhibit more or less adhesion or union, with, perhaps, new-formed and yet tender tissues, *cicatrices*, or granulations with pus or matter on the surface. *The earliest period at which the Authors know of pus being formed* (in their own experience) *is from eighteen to twenty-four hours.*

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* *Inflammation* was formerly held to be explained, or at least comprised, in the four words, pain, redness, heat, and swelling, corresponding to the increased vascularity or increased quantity of blood; the increased sensation, and other nervous phenomena; the raised temperature, due partly to chemical action: and the exudation, causing swelling, and other changes due to pressure. This does not explain the changes in non-vascular parts when inflamed. For modern views of Inflammation, we must refer you to the articles by Dr. Druitt, in his "Surgeon's Vade Mecum," 10th edition, Mr. Simon in Holmes' "System of Surgery," and the article in Russell Reynolds' "System of Medicine."

When the process of repair is replaced by some of the *destructive consequences of inflammation* we see wounds and other sores exhibit some of the following signs of partial or general death, viz.:—*Sloughing* or *ulceration;* this is often preceded by phlegmonous inflammation or erysipelas, with formation of diffused or circumscribed *abscesses* (excessive and unhealthy suppuration). Ulceration of bone and cartilage is usually termed *caries*. *Necrosis* of bone, &c., is the death of a considerable tract of bone, without decay. It is more like general death on a small scale. *Gangrene* usually occurs from an interruption of the circulation, due to thrombotic, or more often perhaps of embolic, plugging of vessels, principally arteries. *Senile* gangrene (which may occur quite independently of wounds) is nearly allied to the change called *mummification*, to which we have alluded in our second chapter. But *traumatic* or acute gangrene, following on wounds and other injuries, is usually moist. It may be confined to the skin, or soft parts at, or near to, and generally below the wound, or may involve a whole limb. *Sphacelus* is another name for the worst form of this *mortification*, being a popular designation. Druitt says, "when inflammation is about to terminate in mortification its redness gradually assumes a darker tint, and becomes purple or blue" [or greenish-yellow and mottled. *Authors*]; "the heat, sensibility and pain diminish, but the swelling often increases, in consequence of the continued effusion of bloody serum, which not unfrequently exudes through the skin, and elevates the cuticle into blisters (or vesicles). If the *gangrene* proceed to *sphacelus* [*i.e.*, goes on to complete death of the part,] the colour becomes dirty brown or black; the parts become soft, flaccid, and cold, and they crepitate when pressed, and emit a cadaverous odour from the gases that are evolved by incipient putrefaction. Whilst gangrene is spreading the dark colour is diffused, and insensibly lost in the surrounding skin; but when its progress is arrested a healthy circulation is re-established up to the very margin of the sphacelated portion, and a bright red line of adhesive inflammation (called the *line of demarcation*), separates the living parts from the dead. And the appearance of this line is most important as a means of *prognosis*, because it shows that the mischief has ceased, and that there is a disposition to repair its ravages." He mentions as causes of mortification or gangrene (1) Mechanical and chemical injuries, particularly gun-shot wounds, compound fractures, burns, the injection of urine into the cellular tissue, as in ruptures of the bladder and urethra; the application of irritants to constitutions weakened by previous disease [as by blisters to children after measles and scarlatina], long-continued pressure [as in bed-sores, tight bandages, &c.]. (2) *An insufficient supply of arterial blood*, as from injury or ligature of a main artery, disease of the coats of the artery and its blocking by fibrine or calcareous matter, as in *senile* gangrene; sloughing of the nose after large losses of blood, pressure on blood-vessels from the effusion of serum, &c. (3) *Impediments to the return of venous blood*, no matter what the cause. (4) *Injury or division of nerves.* Thus the cornea has been known to slough after division of the fifth nerve, a horse's foot after the operation of nerving, &c.

There is a peculiar *white gangrene* of the skin, whose true cause is as yet not known. For the varieties and treatment of gangrene we must refer you to surgical works. To repeat—*If the wounds have been inflicted some days and healthy repair has been checked* by any means, or from any cause, we shall get either *profuse suppuration* and abscess, or some other unhealthy form of local inflammation, with *sloughing* or ulceration, or even mortification or gangrene, that is, death of the part; and this again may be checked, and we may get a *line of demarcation.*

On Traumatic Fever and Delirium, Hectic, Erysipelas, and Pyœmia.

These being all *general* affections deserve a special notice. Our limits do not permit us to do more than briefly notice and define them.

In addition to the first or primary effect of *shock*, which may at once produce death by syncope, or something like it (probably *inhibition* of the heart's action, on which life depends), or a slower death, like *asthenia*, or *collapse*, or both united; almost every wound is followed by, more or less, *traumatic* fever or surgical fever. The best account we know of these is to be found in Billroth's "Surgical Pathology" [first published in the "*Archiv* für Klinische Chirurgie," vol. ii.]. He says slight wounds may not be followed by any febrile movement. But in the great majority of cases a rise of temperature is to be noted on the days succeeding any considerable injury, and this condition, (with the quickened pulse and other symptoms of fever, of which great thirst is often one) is called *wound fever* or *traumatic fever*. The *primary* form of this is usually like an *ephemeral* fever or *febricula.* It is rather sharp at first, but seldom exceeds 104° F. (40° C.), and is sometimes no more than 102·2° F. (39° C.). The defervescence may take place on the first, more often on the second, still more often on the third or fourth, seldom so late as the fifth, sixth, or seventh day of the fever. So that in slight and favourable cases primary traumatic fever is over in a week. But the constitution, the existence of other fevers, &c., may make it more acute. Profuse hæmorrhage may lessen or retard the fever. Complications may be indicated by an immoderate rise of temperature. But in a great many cases, particularly after severe injuries, in hospitals and camps, when there are more wounds than one, and in unfavourable circumstances, when the secretions are pent up, when urine or fæces are retained, when abscesses are forming, &c., there is a *secondary traumatic* fever (Nachfieber of *Billroth*), which is what most surgeons call *surgical fever.* This sets in about the fourth day. Slight cases may last only a few days, or about a week; the severer forms generally begin with a rigor, and may go on for a somewhat indefinite time. [*See* Wunderlich's "Medical Thermometry," p. 357-9, with references in a foot-note, of which we may select a paper on traumatic fever by Dr. Macdonald, in the "Dublin Quarterly Journal," August, 1869, p. 31, and the article in Holmes' "System of Surgery," vol. i., pp. 2 and 287.] Erichsen and other writers describe three forms of traumatic fever :—(1) *Sthenic* or *inflammatory.* (2) *Asthenic* or *typhoid* [not to be confounded with *enteric* or medical "typhoid" fever, the "abdominal typhus" of the Germans, which may, however, attack wounded men], and (3) The *irritative* or *nervous type.* Billroth's "secondary" fever they call *consecutive.* They may all be attended with delirium. This *delirium-traumaticum* is not unlike delirium-*tremens.* It may, however, occur in children who have never taken alcohol, as the Authors have witnessed. The delirium is busy, somewhat fiercer or more furious than alcoholic delirium usually is, and less easily controlled ; the ocular-spectra are perhaps less of the black-beetle type, being usually larger and more varied in form. The skin is less moist than in the alcoholic form. It is also more favourably affected by stimulants and narcotics. As it usually comes on about the third or fourth day after the injury it used to be a practice in the London and some other hospitals to anticipate it in the case of men accustomed to drink, and of an excitable temperament, by giving them a full dose of opium in porter or stout, or more rarely in spirits, or some other accustomed beverage. This prophylactic treatment appeared to be very successful. Erichsen and some others (pages 96-7) describe another form more like delirium-tremens, which he calls "irritative or nervous;" here the skin is cooler and moister, the face pale and haggard, the delirium more of a muttering and suspicious character. Ocular spectra often harassing and terrible. The patient, however, often answers rationally when spoken to. This form is often found in fatal cases. Erichsen says he has known life lost in less than twelve hours when this accompanied simple fracture. In our experience there has usually been some severe (perhaps unsuspected) internal injury to the brain, cord, or viscera, in the cases we have seen of this rapidly fatal form. *Do not forget that a wounded man may have been drugged. Indian hemp, tobacco, belladonna, opium, lobelia,* &c., may all give rise to delirium. The delirium of chronic lead-poisoning is also like delirium-tremens. [Consult also Druitt's "Surgery," Holmes' "System of Surgery," Copland's "Dictionary of Medicine," art. Delirium, and Graves' "Clinical Medicine," p. 452].

Hectic fever means *habitual fever.* The paroxysms usually occur at night, or in the early morning. It is a *late* result of wounds or other injuries, and usually occurs when there are large abscesses or large and profusely suppurating wounds, such as compound fractures, gunshot wounds, amputations, or resections. It is often associated with the *tuberculous* or *phthisical* diathesis, and is thus met with in scrofulous and scorbutic patients, and those who are consequently often the subject of joint-diseases, or caries of the spine, &c.

Erysipelas, sometimes called phlegmonous inflammation, "*St. Anthony's fire*," or "*the rose*," is an unhealthy form of inflammation, which generally commences with a rigor or rigors, attacks first the skin, usually in the neighbourhood of a wound or sore of some kind; spreads into the connective tissue beneath the skin; and may finally involve the connective tissue and fasciæ of muscles and other deeper structures, and invade the peritoneal or pleural cavities; or in the head, the membranes of the brain, and the sheaths of nerves. It hangs about old hospital wards, old workhouses and ancient ships, and is the scourge of camps and fleets in time of war. It infests lying-in hospitals chiefly in the form of *puerperal* peritonitis, with which it seems interchangeable. Old sponges, dirty dressings, dirty towels and bedding, and the unwashed hands or dirty nails of surgeons and dressers, of midwives and nurses, appear to be active in spreading it. Under certain circumstances it appears to change into, or be exchanged for, *hospital gangrene.* On the other hand, some new hospitals, where every precaution is taken, appear infested with it. In a few cases the proximity of drains, sewers, or of a dead-house, have been shewn to be associated, if not chief factors. Some old hospitals again, such as the Glo'ster Infirmary, where the boards are dry-rubbed, instead of being scrubbed, are remarkably free from it.* It is sometimes, though less frequently, met with in private practice when all the surroundings are favourable. One form of this disease wanders all over the body, and is then called *erratic.* If erysipelas be slight, and almost confined to the skin, it is called *simple* or *cutaneous.* The severer and deeper forms are known as *cellulo-cutaneous* or *phlegmonous.* Overcrowding, unhealthy situations, a large number of extensive and open suppurating wounds, dirty dressings, and foul sponges, want of cleanliness in other ways, the presence of *septic poisons*, and, as some say, of bacteria, micrococci, and other germs in the air, the prevalence of certain winds (as those from the north-east), and other circumstances, have been alleged as the true or proximate causes of this disease. It is well known to be both a dangerous and uncertain disease as regards its termination.

Pyæmia again, which derives its name from the supposed presence of pus in the blood [πύον, pus, αἷμα, blood], also spelt pyohæmia, is a diseased state of the blood, doubtless caused by the presence of septic, or unhealthy materials in the blood, which cause the coagulation of fibrine, and effusion of this and of blood; as well as stasis and arrest of the red blood-discs, in various organs and cavities (such as the lungs, liver, heart, &c.), and in the interior of joints. Thus *secondary or metastatic* abscesses are formed in various parts. Usually the immediate wound (which generally involves the cancellous tissue of some bone more or less immediately) suppurates less freely, or even becomes almost dry, and the patient has severe rigors at odd times, perhaps several in an hour. His temperature rises, his skin becomes yellowish; he has a peculiar sweet earthy smell (beet-roots, parsnips, &c., have been considered like it). There is high fever, with complications of meningitis, pericarditis, pleurisy, pneumonia, peritonitis, and joint affections, &c. It may be, and often is, confounded with acute rheumatism, typhoid and typhus fevers, and other maladies. An attempt has been made by some surgeons to separate it from *septicæmia*, but the distinction is not generally recognised. It is most common after wounds or other injuries of bones, veins, and joints.

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* This statement refers to some six or seven years ago. The authors have no recent statistics on this point.

Mr. Erichsen justly says that boils, carbuncles, diffused abscesses, erysipelas, and erysipelatous inflammation of the veins or lymphatics, (phlebitis and lymphangeitis), often precede its occurrence. The same conditions which generate erysipelas appear to produce pyæmia. Like other diseases whose pathology is imperfectly known, it can scarcely be said that there is any settled or generally recognized treatment. The best results seem, however, to have followed the removal of the patient to pure air, or the enforcement of hygienic measures without moving him; a due attention to the digestive organs or *primæ viæ;* an antiseptic treatment of wounds, and the early opening of abscesses, with the same antiseptic treatment; a liberal, easily digested diet, good wine or brandy given freely, and the use of quinine in large doses.

We have thus dwelt at some length on some of the results of wounds, under the heading of *incised wounds*, because these symptoms are common to all kinds of wounds or injuries; although many of them, pyæmia, erysipelas, delirium, &c., appear to originate occasionally *without wounds* or any obvious lesion; and those just named are, as a matter of fact, more common after *lacerated* and *contused* and *punctured*, than after clean or *incised* wounds. This order has, however, been adopted, in order, as far as possible, to save useless repetitions.

II. *Contused* wounds, sometimes called *ecchymosed* or *bruised* wounds, have already been partially described at page 1047. It is important to remember that some days sometimes elapse "before the bruise comes out" in the language of the populace—in other words, before the discoloration due to effusion of blood, or of blood colouring is manifest. Mr. Syme published a case in the "Edinburgh Medical and Surgical Journal" for October, 1836, in which several days elapsed. It was a compound fracture of the tibia. For this reason, the *ecchymosis* may never be seen at all during life, and may first become evident after death. To this we shall return presently.

Flogging, and blows with a cane or stick are special causes of ecchymosis, though both may produce lacerations. Certain conditions of the blood, as in purpura, scurvy (purpura nautica, and purpura hæmorrhagica), and some forms of anæmia may produce similar appearances in the living body, without any blow at all being struck. Very small purple or blackish spots [which are generally extravasations of blood, rarely exudation of blood-colouring only in a peculiar lake-like form], are called *petechiæ*, as in typhus fever [also called spotted or petechial typhus, or gaol fever]. Larger ones, and by some authors the smaller also, are called *sugillations* (*sugillatio*, a black mark). Those resembling the marks of a whip are called *vibīces* [pl. of vibex, the mark of a stroke? from Ἰβύω, the same as ἰΰζω, to utter a shrill cry or wail, as in flogging]. The English word weal, wheal, or wail, probably has a similar etymology, but differs from the other in signifying a raised patch, due to a blow with a whip, or stick, &c., as in the marks of flogging. You may be asked if ecchymosis is *necessarily* the result of contused wounds. Your answer must be that it is *usually*, but *not* invariably so. The authors have known the kidney, liver, and spleen, severally ruptured by contusions, which left no external mark. Portal and Casper and others, record similar cases. [*See Injuries to Viscera.*] This is the place to make some remarks on—

Corporal Punishment, especially Flogging.

Although flogging with the *cat-o'-nine-tails*, and whipping in any form is now happily banished from both army and navy, except in some special cases, this mode of punishment is still retained for garotting and some other crimes of violence. Magistrates are also empowered in the case of young offenders of the male sex, to order a certain number of blows with a birch rod, not exceeding twelve, or at the most twenty at any one time. Females, no matter what their age, are now very properly exempted from this punishment in all prisons, workhouses, reformatories, and other government or parochial institutions. The use of the birch, in some form or another, yet lingers in many public and private boys' schools, and in some private schools for girls. Those who are curious in such matters, may see accounts of the use of flagellation in various ways by Greek and Roman masters and mistresses to their slaves in Potter's "Grecian Antiquities" (Dunbar's Ed., vol. i., pp. 66, 153, &c., Edinburgh, 1818*), and in the notes to Juvenal, Plautus, and other Delphin Classics. The indecencies and absurdities of the Flagellants in the thirteenth century will be found described in Hecker's "Epidemics of the Middle Ages," and in Milligan's "Curiosities of Medical Experience." Even so late as the end of last century and the beginning of the present one, flogging was one of the commonest punishments for almost every description of crime and offence.† In Russia the *knout* is said to be still one of the commonest of punishments. It is thus described by Germain de Lagny.* "A robust man, full of life and health is condemned to receive fifty or a hundred blows of the knout. * * * * * his hands are bound together, with the palms laid flat against one another. He is laid flat upon his belly, on a frame inclined diagonally, and at the extremity of which are fixed iron rings; his hands are fastened to one end of the frame, and his feet to the other; he is then *stretched* in such a manner that he cannot make a single movement. * * * * * At the distance of twenty-five paces stands the executioner. * * * * * With both hands he grasps the instrument of punishment—a knout. This consists of a thong of thick leather, cut in a triangular form, from four to five yards long, and an inch wide, tapering off at one end, and broad at the other; the small end is fastened to a little wooden handle, about two feet long. The signal is given—the executioner advances a few steps, with his body bent, holding the knout in both hands, while the long thong drags along the ground between his legs. On coming to about three or four paces from the prisoner, he raises, by a vigorous movement, the knout towards the top of his head, and then instantly draws it down with rapidity towards his knees. The thong flies and whistles through the air, and descending on the body of the victim, twines round it like a hoop of iron. In spite of his state of tension, the poor wretch bounds as if he were submitted to the powerful grasp of galvanism. The executioner retraces his steps, and repeats the same operation as many times as there are blows to be inflicted. When the thong envelops the body with its edges, the flesh and muscles are literally cut into stripes, as if with a razor, but when it falls flat, then the bones crack, the flesh in that state is not cut, but crushed and ground, and the blood spurts out in all directions. The knout is fatal in many cases." The same author states that as many as 6,000 blows with a rod are sometimes inflicted on soldiers. He describes a case (p. 184) in which a Swedish prisoner, who had shot at and killed a Russian Prince, was condemned to "run the gauntlet" of this punishment—6,000 soldiers were each to strike him one blow. He had received 2,619 strokes when they feared he would die, and suspended the punishment. It was seven months before he was well enough to undergo a second punishment. As it was determined he should, if possible, undergo the whole 6,000, the punishment was then recommenced, but he died at the commencement of this second torture. A whip with *seven* tails, and a cane or rattan, are said to be common modes of punishment in Russia. The "Popular Encyclopædia" states that the knout is formed of thongs of skin artificially hardened and pointed with iron,—a hundred strokes were formerly considered fatal. The thongs are grooved before being hardened, which causes it to cut the skin. It is said an expert executioner *can* kill with the third blow.

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* The several ways of torturing slaves, says Archbishop Potter, are briefly comprised in the following verses of Aristophanes ("Frogs," Act II., Scene vi.) :—

ΞΑΝΘ. Βασάνιζε γὰρ τὸν παῖδα τουτονὶ λαβὼν,
ΑΙΑΚ. Καὶ πῶς βασανίσω ;
ΞΑΝΘ. Πάντα τρόπον, ἐν κλίμακι
δήσας, κρεμάσας, ὑστριχίδι μαστιγῶν, δέρων,
στρεβλῶν, ἔτι δ' ἐς τὰς ῥῖνας ὄξος ἐγχέων,
πλίνθους ἐπίτιθεὶς,[1] παντα' τἄλλα, πλὴν πράσῳ
μὴ τυπτε τοῦτον, μηδὲ γητείῳ νέῳ.

Persons refusing to plead to indictments were formerly punished in a similar manner in England.

† The regulations of the Poor Law Board expressly forbid corporal punishment (flogging, caning, &c.) to be inflicted on any female child. Forgetfulness of this rule by the Matron of the Barnsley Union in July last (1876), led to an official inquiry, and some censure, although it did not appear that the girls (one of whom was seventeen, the other eighteen years of age) were materially injured. And although a master or mistress is entitled to "moderately correct" a servant or apprentice, by ancient statutes, yet more recent enactments have rendered them liable to be indicted for assault. A parent is at liberty to correct a child, provided the punishment be deserved, and is not immoderate, or disproportioned to the child's age or strength. How far a schoolmaster or schoolmistress stands *in loco parentis*, in the absence of any express or written agreement, seems to be very unsettled. Some schoolmasters, &c. get into trouble (usually from excessive punishments), whilst others are acquitted by magistrates. The flogging of girls (not being their own children) by male teachers, guardians, or masters, is liable to

In our own army and navy it was formerly not so very uncommon for prisoners to die under the lash. It was probably for this reason that the Jewish law limited the number of strokes to forty, which the Jews, to ensure being within the number, made thirty-nine. Deuteron. xxv. 3,

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be dealt with, not as a common, but as an *indecent assault*. Looking at the abuses which might follow an opposite rule, we are not disposed to object to such magisterial decisions of the law.

* "The Knout and the Russians," &c. (Translated by John Bridgeman. David Bogue, 1854), p. 179.

"Forty stripes he may give him, and not exceed." "Of the Jews five times received I forty stripes save one. Thrice was I beaten with rods, &c.," says St. Paul, 2 Corinth. xi., 24-25. The cause of death in these cases was not always the same. Sometimes it was due to *shock* or fright, inducing fatal syncope; sometimes to exhaustion, inducing fatal consequences by œdema of the lungs, or effusion into serous cavities, such as the pericardium, pleuræ or ventricles of the brain; in fact, much the same modes of death as in *burns*. The amount of *tissue* killed, and the extent of skin not only injured but put out of work, must, as in burns, be taken into consideration.

The *flogging block* used at Newgate is said to "resemble a box with a high back. The lid and one side are opened, and the man steps in, placing his heels in notches cut out of a plank parallel to the bottom, and a few inches above it; his toes go under the plank, and when the lid and side are shut his legs are firmly fixed. He then places his hands in holes, like those in the stocks, made in the back of the machine. Consequently all movement becomes impossible. No intimation is given as to when the punishment is to take place, and a man is therefore kept in a state of ignorance as to both day and hour till some fifteen minutes before the time. The punishment is very severe, though the number of lashes seldom exceeds thirty, for the 'cat' has a larger handle, and is made of thicker cord than the 'cat' used in the army. Besides, the executioners are strong men, and not drummer-boys." Mr. Gibson, the experienced surgeon of Newgate, has kindly informed us that no untoward accident has occurred from flogging at Newgate. He is careful to examime the pulse before, and from time to time during the punishment. On the other hand, he has never known excitement of the genital organs produced, probably because the punishment falls chiefly on the shoulders and upper part of the back.

There is usually little difficulty in recognising the marks of a severe flagellation, no matter what the instrument. There are cicatrices, and these often undergo a *cheloidal* thickening and contraction. A few years ago photographs of the marks produced by the flogging of a runaway slave were sold and exhibited in most of the print-shops.

Governor Wall was tried before the Lord Chief Baron, some years ago, for causing the death of a man by excessive punishment, by flagellation. The defence was, that the deceased had destroyed himself, by the immoderate use of spirits, while under treatment in the hospital. The judge laid it down that no man was entitled to place another in so perilous a predicament as to make the preservation of his life depend merely on his own prudence. He further remarked that the long continuance and severity of pain (in flagellation) may be productive of as fatal consequences as if instruments or weapons of a destructive kind were used. Some years ago [Lewes Autumn Assizes, 1860] a school-master named *Hopley* was tried for causing the death of a youth of sixteen (a delicate and somewhat weak-minded lad) by beating him most severely for nearly two hours with a rope and a stick. The skin was little injured, but the muscles exhibited great bruising and laceration, and there were extensive ecchymoses. There were marks of blood on the prisoner's clothing, which he tried to conceal. In general, unless the number of blows be too excessive, some idea of the instrument used may be formed by the bruises or marks. But a broad flat sort of paddle, used by the planters in the Southern States, was said to leave hardly any marks.

III. *Lacerated wounds*, as we have just seen may be caused by flogging, particularly with thongs or whips, as well as by the other means mentioned at page 1048. They are often associated with *considerable hæmorrhage.* They are said to be specially prone to *erysipelas*, and to other unhealthy forms of inflammation. They are nearly sure to *suppurate profusely.* Tetanus and *pyæmia* are also more likely to follow lacerated wounds than to attack clean incisions. It need scarcely be said that the *cicatrix* of a lacerated wound will be less regular and less linear than that of an incised one.

IV. *Punctured wounds*, when they heal, often do so superficially, that is, the external lips or margins of the wound come more or less closely together, and in the meantime the deeper parts remain still unhealed. The external air may still have some access, or some may be pent in; or gases from the intestines; or air from the lungs; or gases from decomposing blood or tissues, or from decomposition of the pus, or other matters, may give rise to septicæmia or pyæmia, or to the formation of large abscesses, or, at the very least, retard healthy healing.

Penetrating wounds, of whatever kind, are very apt to cause what is known as *surgical emphysema.** A good figure of this will be found in Miller's "Practice of Surgery" (ed. 1855), p. 312 (from Larrey). It is the occurrence, during life, of what butchers do to veal in order to make it look plump; they blow air into the cellular (areolar or) sub-cutaneous connective tissue. When a fractured rib penetrates the costal and pulmonary pleuræ, or a bullet or stab does the same; when the trachea or larynx is wounded, or its cartilaginous rings separated, as sometimes happens in violent coughing or straining (as in childbirth); when a sinus (like the frontal) communicating with the nose, is wounded in any way; or when a stab opens at once the abdominal wall, and either a portion of intestine, or the stomach itself; in all these, and perhaps a few other conditions, either atmospheric air, or gases of some kind, get into the sub-cutaneous connective tissue, and cause it to become *crepitant* or *crackling* on pressure, and to feel *doughy*, and to look puffy and bloated. When this emphysema is general (*i.e.*, all over the body, and the original communication remains patent, it may be dangerous; and causes distressing dyspnœa. An analogous condition is presented by *pneumothorax*, only here the air or gas is imprisoned, and there is not any communication with the surface. This is, as before stated, a not uncommon complication of gunshot wounds. Before, however, entering into any more details as to wounds caused by fire-arms, which may be lacerated, contused, punctured, and sometimes like incised wounds (as in the amputation of limbs by large shot), we shall discuss

The Characters of Wounds inflicted after Death.

We have already (in speaking of burns, p. 994) drawn your attention to the distinction between general death of the whole body, *somatic* death, and death of individual tissues, such as the skin, muscles, &c., or the death of parts. It is important to remember that distinction now, for within a few hours of death, from most accidents and from most acute diseases, provided the corpse be fairly young, and the disease be not accompanied with putrescence, we shall get many of the phenomena of life, if wounds be inflicted. As in the case of burns, the authors have themselves made experiments on this subject, with results similar to those about to be detailed. To begin with—

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* This must not be confounded with *emphysema pulmonum*, the result of whooping and other coughs or of violent straining efforts, &c., &c. In that disease (which is generally intended when physicians speak of emphysema), the air-vesicles break down, so that instead of from 75 to 120 to the square inch of lung, the same space only contains a few air-vesicles (alveoli, or air-cells).

1. *Incised wounds*, inflicted soon after death, do not materially differ from those made in life, though, as a general rule, there is less hæmorrhage. The skin and muscles gape open (as may be seen in butcher's meat, particularly veal, in which butchers often cut patterns in the tissues (stars, &c.). Orfila appears to have been the first, or one of the first, to make experiments of this kind. ["Leçons," 2nd ed., vol. ii., p. 540.] His conclusions were that wounds inflicted by a cutting instrument *immediately after death*, could not be certainly distinguished from those inflicted during life. Dr. Taylor and Mr. Aston Key made experiments on amputated limbs, which the Authors and others have repeated with similar results. The original experiments will be found in his work, vol. i., p. 460, &c. One or two will suffice to illustrate our meaning. *Two minutes* after a leg was amputated a deep incised wound was made in the calf; there was considerable retraction of skin, and the adipose tissue protruded; there was not much bleeding. After twenty-four hours a fresh examination showed the edges red, bloody, and everted. There had, however, been little bleeding. There were no coagula adhering to the muscles, and only one or two soft clots at the bottom of the wound. When an incision was made *ten minutes* after amputation it was scarcely possible to confound the wound with one made in life, for there was little gaping, the edges were pale, and there was scarcely any hæmorrhage. But after twenty-four hours there were some clots at the bottom of the wound. *When two or three hours* had elapsed from the amputation there were never any clots, though a little liquid blood was effused. The authors found that in one or two cases retraction of the skin took place as long as ten or twelve hours after the amputation. Those who are familiar with *post-mortem* examinations will not confound the rebound of skin, muscles, &c., which have been rendered tense by accumulations of dropsical fluid or gases, with the gaping of elastic tissues, of which we speak. We are therefore warranted, both by experience and experiments, to state that, unless incised wounds have been inflicted a very short time after death, there will be little difficulty in distinguishing them from those inflicted in life, because wounds inflicted after death (1) Do not bleed like those in living persons,* and hence (2) are free from clots, and (3) generally paler; whilst (4) the edges do not gape, and are not everted, but are in close approximation to each other.

2. As to *lacerated wounds*, it is confessedly very difficult to judge whether they have been inflicted before or after death, except when their character more nearly resembles incised than contused wounds.

3. Of *contused wounds* we have already given the characters in life.

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* Owing to decomposition, and the formation of *lakes* out of the blood-colouring, and sometimes, perhaps, to a watery condition of blood during life, *wounds sometimes bleed afresh after death*. It was formerly supposed that the corpse of a murdered man would thus bleed when touched by the murderer. See the remarkable case of Jane Norkott, and the trial of Standsfield for the murder of his father. Hargrave's "State Trials," vol. x., Appendix, No. 2, p. 29; and vol. iv. p. 283: and the Notes to Beck, *loc. cit.*, pp. 544 and 545. These cases will be noticed again at the end of this chapter.

We have there shown that some time is necessary for the production of the colour changes due to ecchymosis or bruising. So long as the body is warm, and the blood uncoagulated, ecchymoses may be produced. The best authority on this subject is the veteran toxicologist, Sir R. Christison, who made numerous experiments on this point. He found that blows inflicted on a dead body *within two hours after death* gave rise to appearances on the skin similar to those produced by blows during life. In general, however, the effusion was limited to a very thin layer of the fluid portions of the blood, on the outer surface of the true skin; sometimes the blood was effused between the layers of the *cutis vera* or true skin.* Occasionally there was slight effusion in the sub-cutaneous, fatty and areolar tissue. In general, the formation of *clots* or coagula must be taken as indicating that the blood was poured out during life. We have seen, however, in the case of incised wounds, that blood may coagulate when the wound is inflicted on an amputated limb ten minutes after removal from the body. The blood in some forms of death coagulates very slowly, or not at all [scurvy, some cases of purpura, typhus fever, some cases of anæmia, death from nervous shock, rupture to the heart, &c.]. Donné [" Cours de Microscopie," page 52] states that the blood may remain fluid from four to twelve hours after death, and he thinks it seldom coagulates until nearly four hours, although the same blood, in a shallow vessel exposed to air, might coagulate in a few minutes [*see* p. 580 to 582]. Dr. Taylor remarks that in general, contusions produced during life, and in which the effused blood remains liquid, may be recognised by the *extent* of the effusion. If there is a large quantity of liquid blood, and no vein ruptured, effusion must have taken place in life. Again, there is swelling of parts if the blows have been given in life. For Dr. Christison's experiments *see* the " Edinburgh Med. and Surg. Journal," No. 99, p. 247, *et seq.* Changes of colour will only take place in the dead as the result of putrefaction, except in the case of the *retarded ecchymoses* before alluded to.

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* For non-medical readers it may be as well to explain that the skin, or common integument (of which the hairs and nails may be considered as normal outgrowths or appendages, whilst corns, warts, molluscous tumours, horns, &c., are abnormal or pathological outgrowths), consists of—(1) the *epidermis*, *scarf-skin*, or *cuticle*, made up of several layers of epithelial cells of the squamous or tesselated pavement variety, the deeper ones being rounded or elongated, just as those of mucous membranes generally are. The deeper part of this is called the *rete mucosum*, or *Malpighian layer*, and contains the *pigment*, the comparative absence of which renders the skin fair, as in most temperate climes; whilst an abundance of pigment is met with in the negro and other dark-skinned races. The epidermis varies much in thickness according to situation, being usually thick on the soles of the feet and on the hands of those who do hard work. (2) The *corium*, *derma*, or *cutis vera* beneath this is made up of a papillary layer, consisting of numerous papillæ, or little eminences, arranged in rows, with furrows between them, which can be best seen in the thumb. (By pressing the thumb on softened wax a mould of these is obtained with ease.) Each papilla is about 1-100th of an inch in length, and about 1-250th of an inch wide at its base. They contain capillary loops and nerve fibres, and in the lips and the palm of the hand, &c., "tactile corpuscles." Beneath and between these papillæ are elastic and white fibrous tissue, blood-vessels, glands, hair bulbs, and the openings of the glandular structures. There are also *muscular fibres*, especially numerous on the scalp, whereby "each particular hair" can "stand on end, like quills upon the fretful porcupine." The corium varies in depth or thickness from 1-25th of an inch (one millimetre) to 1-8th of an inch (three millimetres nearly). The epidermis is from 1-75th of a line (= 1-900th of an inch = ·002 millimetre) to 1½ lines (= 1-9th of an inch, or nearly three millimetres). Adding both these together, we get 1-20th to 1-4th of an inch for the whole skin (= 1·25 millimetre to 6 millimetres for the total thickness of the skin), but the general thickness, as before stated, is more nearly 1-8th of an inch, or three millimetres. In connection with the skin, this question is sometimes put to a medical witness: "*How fast do the nails grow?*" According to Beau, quoted by Hebra and Kaposi [*see* Mr. Tay's translation of their "Diseases of the Skin," New Syd. Society's ed., Vol. iii., p. 94], a finger-nail grows at the rate of about one millimetre (0·04 of an inch) *in a week*. The toe-nails four times as slowly as the finger-nails, or about one millimetre (0·04 of an inch) in four weeks. Therefore the thumb-nail, which in the adult, including the part hidden by the root, measures about 20 millimetres (0·8 of an inch), will require 20 weeks, or almost five months, for its full development. The great toe nail, averaging 24 millimetres (nearly an inch), including the root, in length, will require 96 weeks, or almost two years, for its growth. Berthold [in Müller's "Archiv.," 1850, p. 156] says that the same nail which in winter required 152 days for its regeneration, only required 116 days in summer. He states, also, that the nails of the right hand are replaced more quickly than those of the left by about a week. Alfred Vogel states that the great toe nail can grow again within a year. One of the authors, however, after an accident, found that quite two years was required to replace the nail of the great toe of the left foot—thus confirming Beau. *See* "Deutsches Archiv. für Klin. Med." Bd. vii. p. 335, for Vogel's account. Dr. Samuel Wilks, of Guy's Hospital, and Dr. Langdon Down, of the London Hospital, have drawn the attention of their students to the furrows left in the nails by some acute diseases, such as fevers, severe attacks of broncho-pneumonia, &c. These must not be confounded with the effects of syphilis.

Thus Dr. Taylor quotes the case of a young man who was seen to strike one of his companions in June, 1870 [*loc. cit.*, p. 463]. The receiver of the blow died instantly. On a post-mortem examination the mark of a bruise was seen over the sixth and seventh ribs on the right side. About a fortnight before this blow was struck deceased met with an accident—a heavy box fell on his right side, knocked him senseless and nearly killed him. Dr. Guppy of Falmouth, who reports the case, says the question was raised, whether the ecchymosed mark on the side was owing to the blow just before death, or to the one fourteen days before. [" Lancet," 1870, 2, p. 35.] On the authority of Casper it was stated at the trial that the ecchymosis could not have arisen from the last blow, because there was not time for its appearance before death. [*See* Casper's " Handbuch der gericht. Med.," vol. i., p. 121.] But Casper has himself admitted that violence applied to a recently dead body will produce ecchymosis. Dr. Taylor justly says the fourteen days' bruise would have shown some changes of colour at its margin. He quotes the case of the Duchess de Praslin [August, 1870], who was assassinated by her husband, and attacked whilst asleep in bed. The number of her wounds, which amounted to *thirty*, showed that she had strongly resisted, but the whole struggle must have been less than *half an hour.* Yet, on inspection, there were numerous ecchymoses, which had resulted from the violent use of a bruising instrument. [" Annales d'Hygiène," 1847, tom. ii., p. 377.] The following case is also to the point. In 1864 a young gipsy-woman fell under a waggon wheel; it was said not to have passed over her body. She was pregnant, and the injury lacerated her right kidney, tearing it almost in half. When examined half an hour after, there were no bruises on the body. She lived in all about six hours, and no marks of bruising [ecchymosis] appeared until the next day—nearly twenty-four hours. The usual colour-changes went on till the post-mortem examination took place [about four days after]. There are, however, not a few cases on record where severe contusions have produced no mark on the outside of the body. Of this Dr. Taylor gives numerous cases [pp. 461 to 479]. We shall quote some further on.

A careful consideration of the subject brings us to the conclusion, that it is often extremely difficult to say, from the mere appearance of the wounds or bruises, even on dissection, whether contusions were inflicted during life or just after, or at a period some time after death. *Collateral circumstances, may, however, sometimes assist in forming a decision,* as they do in the case of incised or other wounds. As, for instance, in the case of *Greenacre,* committed in 1837 for murdering and mutilating a woman, it was found that the head of the deceased was severed from the body; the question arose, was this done during life (so killing her), or after death? The surgeon, Mr. Girdwood, though properly expressing himself cautiously, and replying that the wounds in the neck (whose edges were retracted) were inflicted either during life or whilst the body was still warm; yet very strongly inclined to the opinion that the woman was alive, because the head was almost bloodless (drained of blood), which showed that the circulation was going on at the time the head was cut off. In post-mortem decapitations but little blood escapes, except from the jugular veins. The circumstantial evidence tended to show that this victim was first stunned and then beheaded.

4. *Punctured and penetrating wounds inflicted after death* are chiefly distinguished by the small loss of blood, unless they happen to hit an enormous vein, or an artery containing fluid blood. *See* the case of Sir Edmundbury Godfrey, p. 952, &c.

If possible the dress should be examined also for blood. Whether inflicted before or after death, sword-wounds, or similar injuries, traversing the body (*i.e.*, passing completely through it), generally have a large depressed orifice of entrance, and a small and raised orifice of exit. [*See* also Gunshot Wounds.] The amount of hæmorrhage in the case of stabs depends much on the sharpness of the weapon. With a blunt sword, spear, &c., there may be very little blood lost, even in life.

The sharp ends of a fractured bone may be thrust through the skin by muscular action, or in attempting to walk, and thus simulate a punctured or penetrating wound.

It seems convenient to sum up the general results of these experiments and experiences in a tabular form. In using the table remember, however, that there are exceptions; and the characters in the table must be regarded rather as verbal averages or *means* than as strictly true in all individual cases.

Table of Characters of Wounds inflicted in Life, and after Death.

I. *Of Incised Wounds.*

A.—IN THE LIVING.	B.—IN THE DEAD.
1. Edges sharply cut and *everted,* the skin and muscles being retracted.	1. Edges close, and *not* everted.
2. Bleeding copious, and generally *arterial.*	2. Bleeding scanty, or absent, and generally *venous* when there is any.
3 There are clots or coagula.	3. There are no clots or coagula in most cases; sometimes a few small clots.
4. There is a good deal of staining or diffusion of blood in the muscular and connective tissues.	4. There is very little or no staining or diffusion of blood in the tissues of the wound.
5. After some hours, or days, there will be signs of *repair* or of *inflammation.* (Partial or complete union, pus, granulations, erysipelas, mortification, &c.)	5. There will be no attempt at repair, and no signs of inflammation. There may be withering or *parchmentation* of the edges, and signs of putrefaction.

II. *Contused Wounds.*

A.—In the Living.	B.—In the Dead.
1. There is swelling, and after a few hours, or a few days if deep seated, the skin changes colour—not blue, but violet, greenish or yellowish, particularly at the edges.	1. There is very little swelling or change of colour.
2. There is effusion of liquid blood and lymph in the deeper parts, and coagula form.	2. Very little blood is effused. There are hardly any clots or coagula.
3. The swelling subsides, and the colours fade after some days, or in some cases weeks.	3. There are no rainbow-like or prismatic changes of colour.
4. Abscesses may form, or ulceration and sloughing (local gangrene), or erysipelas set in.	4. No abscesses form, and no erysipelatous or gangrenous changes are met with.

III. *Lacerated Wounds.*

A.—Inflicted during Life.	B.—After Death.
1. There will be more hæmorrhage and staining from the blood at first.	1. There is hardly any hæmorrhage or staining, unless large veins are torn across.
2. After a few hours, or days, there will be suppuration or other signs of repair; inflammation or gangrene may also supervene as in incised wounds.	2. No evidences of repair, or of inflammation, or gangrene (mortification) can be detected.

N.B.—With some lacerated wounds, particularly those done by violent twisting, as when an arm is torn off by machinery, or fingers are caught by steam-saws, &c., there is hardly any hæmorrhage, even in life. This is probably due in general to the *torsion of the artery* (torsion being one of the means surgeons use to check hæmorrhage), but in some cases the contusion or compression undergone by the blood-vessels is the most probable explanation.

IV. *Punctured and Penetrating Wounds.*

A.—Inflicted in Life.	B.—Inflicted after Death.
1. As in the lacerated wounds, there is generally considerable hæmorrhage in life, unless the weapon is blunt.	1. There is little or no hæmorrhage or coagulation of blood.
2. Repair or inflammation, or necrotic changes set in after a few hours, or days, as in other wounds.	2. There are no evidences either in or around the wound of repair, inflammation, or death of tissues (necrotic changes).

N.B.—Gunshot wounds are generally lacerated and penetrating. There may also be severe contusions.

The Duties of Surgeons in regard to Wounds.

It is clearly not our province to lay down minute directions for the surgical treatment of wounds or injuries of any kind. We must refer you to the systematic writers on surgery, and to the practice and monographs of the surgeons to the great hospitals (military and civil) of England, France, Germany, Italy, and America, &c. The chief objects aimed at in the treatment are :

1. The arrest of hæmorrhage [by cold, position, pressure (by tourniquet, or otherwise), ligature of arteries and veins, torsion, acupressure, cautery, escharotics and caustics, styptics and hæmostatics.]

2. To obviate the tendency to death from shock, syncope, and other immediate results of injuries.

3. To prevent undue inflammation and excessive pyrexia, and to ward off or skilfully treat tetanus, pyæmia, and other untoward sequelæ.

4. To restore as far as possible the natural relation of parts, both for cosmetic and economical purposes; as by sutures in skin, nerves, &c., by the use of splints in fractures and other lesions; by the removal of hopelessly damaged parts; and the preservation of even one finger, or a part of one if it promise to be useful; and by the prevention of deformities, by plastic operations, skin grafting, &c. [Conservative and Plastic Surgery.]

The total removal of a hopelessly damaged limb may sometimes be more truly conservative than an injudicious attempt to retain it.

Supposing, however, that mistakes have been made in any of these directions, and we know how very human it is to err, these mistakes belong rather to the section on *malapraxis*, to which we must refer you for the general principles. [*See* page 712.]

Your medico-legal duties must, however, be briefly pointed out. These are:

1st. A careful examination of the wounded person, of his or her dress and surroundings, and of the wound itself, as well as of the weapon or weapons where practicable. In some cases you may also have to examine the person, clothes, and weapons of the supposed or actual assailant.

2nd. You will be expected to make notes, draw up a report, and probably afterwards to attend at either the police-court, inquest, or superior criminal court, and give evidence. Whilst in some cases

3rd. You may have to receive what are called,—

Dying Declarations from the Wounded or Injured Persons.

For obvious reasons, chiefly those of space and simplicity, we will take these points in reverse order, and begin with dying declarations. The Act 30 & 31 Vic., cap. xxxv., sects. 6 and 7, contains enactments with regard to dying declarations, and makes provision, amongst other things, for prisoners being present when they are made. The one essential, according to the ruling of our judges in a vast number of cases, being, that the wounded or injured person, male or female, shall believe, or, at all events, profess to believe, that he or she is in actual danger of death. Such declarations are admitted as evidence both in England and Scotland. It is allowable for a medical [or other] witness to give *parole* (or by word of mouth) evidence of a dying declaration, but more weight is attached to it when taken down in writing in the presence of witnesses. These witnesses should, if possible, sign the paper. If a magistrate, or other legal functionary, be present, the medical man in charge of the case should of course not interfere further with the declaration than by giving his opinion as to the hopelessness of the case, or of the state of the dying person's mind. In the case of stabs, gunshot wounds, and some other severe injuries, death is sometimes so sudden that there is no time even to pencil down the words of the dying man. Should a medical man be present he should (whilst endeavouring to prolong life as long as possible) listen quietly to such statements, only interrupting when he does not hear or understand, and suggesting nothing. This done, he should write down the words at once as soon as he can get at writing materials, and if others have heard them, read over what he has written, and thus get it attested. In such cases there will rarely be any doubt in the minds of either the bystanders or of the dying person as to his real condition of impending death. But, remember, it is the dying person's conviction that he or she is dying that is important. The law presumes that in so solemn a crisis no one would willingly leave this world with a lie in their mouth, and that if at such a moment an accusation is made, it is at least sincere.[*] In the case of *Jenkins* [Crown cases reserved, April, 1869], a statement was rejected because the dying person, in using the expression, "I have no hope of my recovery," requested that the words "at present" should be added. And in *Regina* v. *Londesborough* [York Lent Assizes, 1871] Mr. Justice Brett declined to receive a statement because the evidence went no further than this—the dying youth said he thought he should not get better. Should, however, the apparently dying person recover, the statement made under fear of impending death may still be used. "It is," says Dr. Taylor, "the proof of the sense of impending dissolution which determines its admissibility." Chief Justice Erle, in Seton's case [*Regina* v. *Pym*, Hants Lent Assizes, 1846], said, "The law admits these declarations, not because recovery is impossible, but because there is in the mind of the person making them the conviction of approaching death." The medical witness, says Dr. Taylor, should not be officious in extracting information, but should content himself with what is *voluntarily uttered*, and should write down the *identical words*, and not his own interpretation of them. Dr. Guy (*loc. cit*, Introduction, p. xxvii.) expresses the same meaning in very similar terms. Beck, on the same subject, refers to Starkie on "Evidence," vol. ii., p. 460; Ryan, p. 301; Paris and Fonblanque, vol. i., p. 166; and gives the following case:—"On the trial of Mr. Christie and Mr. Trail for the murder of Mr. John Scott, the editor of the 'London Magazine,' and author of various works, in a duel: Dr. Darling, who had attended the deceased after he had received his wound, deposed that he heard Mr. Scott, on his death-bed, say ——

Mr. Justice Bailey. Did Mr. Scott at that time think himself in danger; did he give up all hopes of recovery?

Dr. Darling. No; to the last he entertained hopes of recovery.

Mr. Justice Bailey. The declaration made by a dying man cannot be received as evidence unless the party at the time of making it were satisfied that recovery is impossible."[†] [p. 970.]

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[*] It may be sincere without being true. Dr. Taylor cites (p. 455) the case of a dying woman, in St. Thomas's Hospital, who accused a man of assaulting her on Kennington Common, with others. He was found guilty, and executed. A year after his execution the real murderers were discovered, and his innocence established. A fine argument for capital punishment!

[†] The following cases, quoted by Taylor, may be referred to on this point:—

(1) Chief Baron Pollock ruled in *Reg.* v. *Bayley* (Exchequer Chamber, Jan., 1857), that although the surgeon had given some hope to the dying person before the declaration, his declaration might be taken as evidence, because, in spite of his surgeon, he believed he should not recover. (2) *Reg.* v. *Harvey* (Exeter Summer Assizes, 1854), Justice Wightman. (3) *Regina* v. *Wanstell* (Leeds Autumn Assizes, 1869, and *Reg.* v. *Pettingill* (C.C.C., April, 1872), Baron Cleasby ruled that the dying person must either expect death, or death be imminent, even when a magistrate has taken the deposition. (4) In *Regina* v. *Barrett* (Leeds Lent Assizes, 1869) Baron Cleasby ruled against a declaration because the strongest statement was that "she thought she should not recover." (5) In *Regina* v. *Qualter* (Stafford Lent

As regards your duty in drawing up a formal report, or giving evidence in the coroner's or any other court, we have little to add to our recommendations already given in chap. i., pp. 3 and 4. In making a post-mortem examination, the advice given you in chap. ii. (pp. 8-12) will assist you; whilst in giving your evidence, or in drawing up a formal document, the data given from pp. 621 to 666, and 779-783; and the model reports under Infanticide and Insanity, p. 793 and p. 860 to 867, will serve to show the style, at once simple, clear, precise, and natural, which you should follow. You need not aim at imitating legal phraseology. If you do, unless you have studied law, the result will probably be a ridiculous failure. In any case the prolixity allowable in a legal document is quite out of place in a medico-legal report.

We are therefore brought back to the consideration of your duties in the first point, *of making a careful examination of the wounded person, of each wound, of their clothes, of the surroundings,* [*i.e.*, the place where they are found, of articles of furniture, &c.], of *any weapons* or *articles which might be used as such,* or form parts of weapons [bullets, portions of firearms, broken knives, portions of bludgeons, hammers, axes, &c., would all come under this category]; *as well as, in some cases, a careful examination of the prisoner, or suspected person or persons, of his clothes, and of weapons, &c.*, in his possession, or supposed to belong to him. We shall try to illustrate each of these points in succession.

A. *It is very necessary to carefully examine the wounded person,* because

(1) There may be more wounds than one. There usually are in attempts to murder, except in some cases where firearms are used. Even here, as we shall see further on, one bullet may produce two wounds. There were more than thirty wounds in the case of the Duchess de Praslin (noticed by us at page 1074). *Mr. Briggs*, murdered by Müller in a carriage on the North London Railway in July, 1864, had several wounds on his head. There was a transverse jagged wound across the left ear, and above this there was a scalp tumour, and two distinct wounds of the scalp with effusion of blood beneath, and corresponding fractures in the bones. *Mrs. Gardner*, the sweep's wife [*Reg.* v. *Gardner*, C. C. C., 1862], had numerous cuts on her hands, but died from the wound in her throat. In a case tried at New York in September, 1839, the poor woman who was murdered had eleven wounds: eight stabs in and about the left side of the thorax, one of which had penetrated the pericardium, and divided the pulmonary artery near its origin; the others were on the back, near the left scapula. Dr. Proctor, of York, found *fifty-six* wounds, many of them severe, on the body of a woman murdered by her husband, who killed her in a fit of delirium tremens. In the *Wadsworth Moor Murder* of Bethel Parkinson, by Joseph Shepherd (York Assizes, March 15, 1858), Mr. Howard, a surgeon who examined the body, found thirty-four incised wounds, five broken ribs, and the skull "literally

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Assizes, 1854) the surgeon was, as we think, unjustly blamed for the escape of the criminal through a technicality of this kind.

See also the case of *John Clark*, tried in December, 1783, for "killing and murdering *Thomas Johnson* by stabbing him in the belly," &c. "The declarations of the deceased," said the Judge, "after receiving the death-wound, are always considered as admissible evidence in cases of murder, though nothing before that wound is considered in that light. The man is in health; he receives his death-wound; he declares his own idea of it that it will be mortal," &c. ("Select Criminal Trials at Justice Hall in the Old Bailey," Vol. i., Appendix, p. 32, &c. Edinburgh, 1803.)

smashed and battered in." *Upon the coat there were found twenty-four cuts, twenty-five upon the waistcoat, and thirty upon the shirt.* If it were necessary to multiply cases of this kind, we might quote again the murder of Andreas Rauscher, to whom George Rede (*see* page 907) gave eight wounds on the head, besides others elsewhere. Feuerbach ["Merkwürdige Criminal-Rechtsfälle"] gives many others. A perusal of the police reports in the daily newspapers would furnish examples in great numbers.

(2) There may be no wound at all on the surface of the body, and yet life may be imperilled or destroyed by serious injuries. We have before remarked, that the kidney and other viscera may be ruptured by external violence, without any mark being found, at least, at the time, on the surface of the body. The murder of King Edward II. at Berkely Castle is said to have been perpetrated by first introducing a hollow horn (a sort of rude *speculum ani*, made of cow's horn) into the rectum, and then passing through this the red-hot blade of a kind of sword; they still show a weapon which might very well have served for the purpose. Under *wounds of the genital organs* we shall mention other cases in which murder has been perpetrated by wounds through the vagina, uterus, &c. The brain may be fatally injured through the ear or the nostrils, &c.; and there may be fatal injuries to the carotid arteries, and other important structures, through the mouth, or rather throat. Again, a careful inspection of the hairy scalp is necessary, since death has been known to result from the tiny bullet of a toy pistol, which when fired tolerably close, might leave an exceedingly minute opening.

(3) There may be no wound at all, either internal or external, in the ordinary sense of the word, and yet death may result from criminal violence. We must remind you that a sudden blow in the epigastrium has proved fatal—as is supposed from injury to the solar plexus. Death may result from fright inducing syncope, or collapse from shock; or there may be internal extravasations of blood, as in the brain or its membranes, and elsewhere also—an event specially liable to happen in drunkards, old people, and those suffering from degenerations of blood-vessels. Or the *heart* itself may be ruptured by strong excitement when its walls are very thin, or when they have undergone fatty, calcareous, or brown (fibroid) degeneration; so that "a broken heart" is sometimes a literal fact.

(4) Again, there may be wounds, and wounds of some severity, and yet death may not be directly, or sometimes in any way, due to these. Most writers on Medical Jurisprudence quote cases in evidence of this. As for example: Beck cites the following from Mr. Shaw's "Manual of Anatomy," vol. i., p. 46. "An industrious workman, returning home found his house empty of everything, his bed and the tools of his trade sold for gin by his wife, whom he found in a gin-shop, drinking and dancing. He brought her home, and in the passage of his house struck her, and ordered her to go up stairs. She refused, he carried her up upon his shoulders, and the contention continuing up-stairs, again struck her. There having been no one else present, we have only the husband's account of her death. He said, that whilst sitting on her chair, she fell down, upon which he threw her on the bed, conceiving she was in a fit, such as he had seen her in formerly. Some of her neighbours coming to her found her dead. Sir Charles Bell examined the body, and deposed as follows on the trial. There was nothing very remarkable on either

thorax or abdomen, except a quantity of gin in the stomach, and a blush of redness about the pylorus and duodenum. On the head there were several bruises, but the bone was not hurt, and there was no extravasation under it. The vessels of the pia-mater were empty, as if from pressure. Under the arachnoid there was extravasation of serum, and the same in the ventricles, such as is common in persons who die of intoxication. On the surface of the brain there appeared to be spots of extravasated blood, but these could be traced to ruptured vessels at the base—the base was covered with extravasated blood, in which all the roots of the nerves were involved [*see* diagram of base of brain at page 881]. The blood had penetrated into the ventricle [? 4th] by perforating its floor. And on removing the brain and tracing the vessels, the anterior cerebral artery coming off from the left internal carotid was found half torn across, and from this the blood had come. Now this rupture had been the cause of death; as to the cause of the rupture itself, Mr. Bell's opinion coincided with the best authorities in pathology, that there is a state of the vessels in which an external injury or shock is more apt to produce rupture; and drunkenness may be supposed to be the artificial state of excitement which most resembles this state of the vessels. Being asked whether the blows were the cause of the rupture, he said, he conceived it very likely that a shock would rupture the vessel; and being then asked whether he conceived that this woman was more likely to have a vessel ruptured from being in a state of intoxication, he replied that he was of opinion that intoxication and the struggle [together] were likely to produce such a degree of activity of the circulation in the head, that a less violent blow might produce rupture, than what, in other circumstances, might have proved fatal." The man was acquitted. Mr. Shaw adds, that in an almost precisely similar case, a man was condemned upon clear evidence of his intention to commit murder. But Beck goes on to say [foot-note to page 617], that a parallel case to the one in the text is given from a French source, in the "Med. Chirurg. Review," vol. iv., p. 969; in which a *drunken quarreller fell dead without a blow*, and on dissection, *enormous extravasation was found* in the brain. He refers to the article on drunkenness [*Ivresse*] in the "Dictionaire des Sciences Médicales." The Authors know of several similar cases. Whilst, as Beck remarks, there are other cases in which the evidence of direct injury to the brain, produced by blows received by drunken persons, has been clear, unmistakable, and not to be gainsaid.* And again there are cases in which *external wounds are found, but on post-mortem examination and analysis, there are clear evidences of poison.* Dr. Taylor quotes from *Wildberg* a case, in which a girl died whilst her father was chastising her for stealing. Wildberg examined the body. Many marks of blows were found on the arms, shoulders, and back, under some of them there was a good deal of blood effused. He thought the injuries scarcely severe enough to cause death, and proceeded to examine the interior of the body. *On opening the stomach he found it much inflamed, and lined with a white powder which proved to be arsenic.* It turned out that on the theft being detected, the girl had taken arsenic from fear of her father's anger; she vomited during the flogging, and died in slight convulsions. Upon this Wildberg imputed death to the arsenic, and the man was discharged. The late Dr. Geoghegan told

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* *See* Mr. Watson's case, "Ed. Med. and Surg. Journal," vol. xxxvii., p. 97.

Dr. Taylor of a case in which *a gentleman took eleven grains of strychnia, and then threw himself out of window, and sustained great bodily injury.* The surgeon finding so much spasm, made inquiries, which led to his patient's confessing, and he also got evidence of the purchase of the poison. Dr. Taylor refers to some good suggestions on this point in Belloc's "Cours de Médicine légale," p. 148, a book from which we have quoted on some other topics. *See* also the remarks in our early chapters on poisons, pp. 31 to 57. The finding of food, or the opposite state of an empty stomach may also prove the truth or falsehood of a prisoner's statement. As in the case of *Reg.* v. *Spicer* [Berks Lent Assizes, 1846], where prisoner said he heard his wife fall jûst after they had their dinner. Mr. Hooper, the medical witness, found her stomach quite empty! Thus disproving the prisoner's story, as there was no evidence of violent vomiting.

Always, therefore, examine the stomach and its contents in *making a post-mortem.* Do not, however, attribute every redness to the action of poison. *See* Chapter II., and the chapter on poisons, quoted above. *In living persons who are wounded,* you should look (after attending to the wounds) for signs of present or past diseases, and diseased conditions [examination of thoracic organs by auscultation or percussion, examination of urine, &c., &c.].

B. In the next place, *examine carefully each individual wound.* As regards the living, you would of course do so, in order to treat the wounds properly. As we shall see when treating of gun-shot wounds, there is some difference of opinion as to the propriety or otherwise of *probing* certain wounds—viz., those running a deep and perhaps circuitous course, but more especially those which either certainly or probably involve either the brain or spinal cord, large blood-vessels or important organs and viscera, such as the eye, ear, heart, lungs, liver, spleen, bladder, and the like. In our judgment, such questions would hardly ever arise if all surgeons remembered what Dr. Blundell calls "the golden rule" of obstetric medicine—"*Arte non vi.*" "It is force," says he, "not the forceps, that kills!" And so we would say—It is not the *probe* which injures, it is the *forcible pushing* the probe, where it would not spontaneously go. In truth, a probe should be held lightly, though firmly. If of metal, it should be of either pure silver or of some soft metal, and it should be regarded as a mere lengthening of the surgeon's finger. In some cases a fine bougie or catheter, or something made of vulcanite, or of linen covered with a composition of wax, &c., or catgut may take the place of a metal probe. Used gently and with judgment, the probe, of whatever kind, will give valuable indications, and do no harm. In examining a wound for medico-legal purposes, look—

(*a*) To its superficial dimensions and its situation. The length and breadth of a wound, if at all considerable, or likely to be a matter of trial, should always be *measured in inches and parts of an inch.* If you like to use French measures, by all means do so, but remember to translate or explain them by their English equivalents when giving your evidence, or in written documents.*

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* The table at page 600 gives the relations of English inches to millimètres, old Paris lines, and Prussian lines. The following memoranda may be useful to you in reading works on Forensic Medicine, particularly foreign ones :—

English Measures of Length.

12 lines, or 3 barleycorns equal 1 inch. (On carpenters' and other rules the inch

In general very extensive and deep wounds are supposed to be *homicidal* or to indicate *murder*. If very numerous, they probably do so, but their *depth* and *direction* must be considered. We have ourselves known *suicides* inflict very terrible wounds on themselves [*see* Illustrative Cases]. Beck, Casper, Guy, and Taylor, and most French and German authors agree with this statement. Whilst recommending you to be exact in the measurement of wounds, we do not advise you to state them too minutely in your evidence. A jury would understand you far better if you said a wound was about *four* inches long, than if you stated it as 3·95 inches. For in general both vulgar and decimal fractions are but little understood by the populace.

(*b*) The *situation* of a wound is often of considerable importance. There are some parts of the body, as all who have been accustomed either to gymnastics or ablutions with cold or hot water, can testify, which are either not capable of being reached at all, or reached only with extreme difficulty. A *suicidal wound* is therefore, in general, *on the front of the body, and in parts which are reached with ease.* Thus the throat or chest, the forearms, and the thighs or groins are favourite seats of suicidal wounds. But murderers may, and often do, select the same sites. Dr. Gordon Smith ("Forensic Medicine," p. 302), is very rash in saying that if a bullet or shot-wound is made from within the mouth, we may "take it for granted that it is not made by another," and therefore suicidal. Because, as Dr. Taylor justly says, a cool and calculating murderer may easily attack a sleeping or feeble victim in this way. Still, we may certainly admit, if other evidence does not point to murder, that finding

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is also divided into quarters, eighths, tenths, and sixteenths, as well as twelfths.) 12 inches = 1 foot. 3 feet (36 inches) = 1 yard. 4 inches = 1 hand (used in measuring horses). 3 inches = 1 palm. 3 palms (9 inches) = 1 span. 5 feet = 1 pace. 6 feet = 1 fathom. 5½ yards (16½ feet) = 1 perch or pole English. 7 yards (21 feet) = 1 Irish perch. 40 perches (660 feet) = 1 furlong English. 8 furlongs (or 1760 yards, or 5280 feet) = 1 mile English. 11 Irish miles = 14 English ones.

French Measures of Length.

1 millimètre = 0·03937 inches English. 10 millimètres or 1 centimètre = 0·39371 inch English. 10 centimètres or 1 decimètre = 3·93708 inches English. 10 decimètres or 1 mètre = 39·37079 inches English, or 1 yard, 3 inches, and $\frac{37}{100}$ths of an inch nearly. 10 mètres or 1 decamètre = 10·936331 yards. 10 decamètres or 1 hectomètre = 109·36331 yards. 10 hectomètres or 1 kilomètre = 1093·6331 yards. Or 1 inch = 2·539954 centimètres; 1 foot = 3·0479449 decimètres; 1 yard = 0·91438348 mètre; and 1 mile = 1·6093149 kilomètre.

German Measures of Length.

12 Austrian punkte make 1 linie = 0·0864 inch English. 12 linien = 1 zoll or inch = 1·0371 inch English. 12 zoll make 1 fuss = 12·445 inches English. The elle is 30·66 inches, or 2·555 feet. The Austrian mile is 8297 yards, or 4·7142 miles English. In Hanover 12 linien make 1 zoll, or 0·95 inch English; and the fuss of 12 zoll equals only 11·45 inches, or 0·9542 foot English. In Prussia 12 scrupel = 1 linie, or 0·086 inch English; 12 linien = 1 zoll, or 1·03 inch English. The fuss (Rhein-fuss) is therefore 12·357 inches, or 1·0298 foot English; and the mile (meile) is 8238 yards, or 4·6807 miles English. In Baden (Germany) 10 punkte make 1 linie = 0·118 inch English. 10 linien = 1 zoll, or 1·181 inch. 10 zoll = 1 fuss, or 11·811 inches or 0·9842 foot English. 10 fuss = 1 ruthe, or 9·8425 feet English, = 3 French mètres. In Saxony 10 linien make 1 zoll = 0·929 inch English. 12 zoll = 1 fuss, or 11·148 inches English = 0·929 foot English. The meile (mile) is 7432 yards, or 4·2227 miles.

For the measures, &c. of other continental and foreign states, see "The Weights and Measures of all Nations," by W. S. B. Woolhouse, Esq., F.R.A.S, in Weale's Series.

wounds in an exposed and anterior region of the body, is in favour of their being suicidal.

(*c*) The *shape* or *form*, and *depth* of wounds sometimes points to the hand of a murderer. For example, in a midland county, some years back, a farmer was found, with his throat cut, lying on a high road, with his pockets rifled. On examining the wound, the surgeon discovered that the knife had been entered deeply just below the ear, and that the carotid and jugular, with the throat and windpipe, had been cut from behind forwards; the shallowest part of the wound being at the point of exit. In fact, it was done just as a butcher might cut a sheep's throat. The prisoner, who was subsequently tried and executed for this crime, had, it appeared, been a butcher. [*See* Guy and Taylor.] Orfila quotes a case in which the body was divided into two, between the third and fourth lumbar vertebræ, just as butchers divide animals, and this led to the arrest, trial, and condemnation of a butcher. Sometimes the neat way, so to speak, in which joints are disarticulated, or a body opened, or decapitated, has led to the suspicion that the perpetrator of the crime was an anatomist, or a surgeon, or at least, a medical student. It should, however, be borne in mind, that many lads, especially in country villages and small towns, are fond of watching the manœuvres of butchers. Also that in medical schools and hospitals, where there are Faculties of Arts, Law, Theology, &c., others, besides medical students, often witness dissections and operations on both the living and the dead subject. The depth of a wound may be conveniently taken by means of either a probe or a small bougie, comparing it with a measuring rule or tape, this should be gently insinuated under the edges of the wound, and then, if we are making a post-mortem examination, we may surround the wound in this manner (|) by a couple of semi-lunar incisions: and thus preserve the relation of the external parts, skin, muscles, &c., to the deeper portions of the wound.

(*d*) *As regards the nature of the wound*, we have before explained the principal characters of wounds of different kinds, incised, lacerated, contused, penetrating, &c. We need not, therefore, repeat what we said, but pass on to notice that—

(*e*) The *direction* of a wound is considered by many writers on this subject to be of very great importance. Thus suicidal wounds of the throat, generally run from left to right, when inflicted by persons who are right-handed. Such persons cut pretty straight across, and often very high up, just between the hyoid bone and the thyroid and cricoid cartilages. The larynx or wind-pipe [organ of the voice] is thus wounded and cut across, but the carotids and other large vessels often escape, particularly if the knife be somewhat blunt. A *left-handed person* would of course cut in the reverse direction. It has, therefore, been recommended to place a knife or razor (the very weapon found, or one that is capable of inflicting a similar wound, in the right hand of the deceased [or *vice versâ* in the left hand], and see if the incision could have been easily made in such a direction. It has, however, been remarked in answer to this, that if a murderer went behind his victim, he would inflict a similar wound in the throat as the person himself, according to which hand he used. In some cases it might be found that the hand of the murdered person was incapable of reaching the wounded part. You must, of course, in making such an experiment, overcome post-mortem rigidity, if present, by forcibly bending the limbs, fingers, &c.,

backwards and forwards a few times. Similarly, a stab or punctured wound inflicted by a suicide is commonly from right to left, and from above downwards, since this is the easiest way to make it. Suicides are sometimes very ingenious in contriving odd ways of injuring themselves. We have known a lunatic fix a knife in the chink of a floor, and another place one in a *carpenter's vice*, and then the wretched men impaled themselves upon the weapons they had thus fixed. In such a case the stab was, of course, from below upwards. One of the Authors knew a man whose hands were partially disabled, who fixed a string to the trigger of a pistol which he held between his teeth, and pulled this with his feet. Soldiers, and some sportsmen, who commit suicide with a rifle, musket, or fowling-piece, placing the further end of the barrel inside their mouth, adopt a similar manœuvre, because in such a position the trigger (if the gun be a long one) is out of reach of their hands. They also make use of the ramrod to fire the gun. The remark made before about cut-throats applies, in part, to stabs and punctured wounds done by murderers. That is, if the murderer goes behind his victim, the stab may very probably be from right to left, and from below upwards. If, on the contrary, he attacks his victim from the front, it is most likely that he will stab in an upward direction, and from left to right. Again, "homicidal incisions in the throat," as Dr. Taylor justly remarks (p. 486), "are often prolonged deeply into the soft parts below and behind the skin forming the angles or extremities of the wound." Again, "oblique wounds, passing from above downwards, are common to homicide and suicide, but those which take an oblique course from below upwards are generally indicative of homicide, for it is extremely rare that a person bent on suicide, unless a lunatic, thus uses a weapon." Suicidal wounds of the throat, &c., are rarely deeper in the soft parts than in the skin, usually, "they terminate gradually in a sharp angle, and the skin itself is the farthest point wounded—the weapon is not carried either behind, below, or beneath it." Dr. Ogston ["Med. Times and Gazette," January 20, 1877] calls attention to the fact, that a single thrust or stab from a weapon which is withdrawn with a twist of the wrist, will inflict a wound with a sort of tail or offshoot, like a Greek gamma, thus γ, so that we might almost suspect that there had been two stabs. He also points out that cylindrical weapons, such as some bayonets, &c., will sometimes inflict wounds with two sharp angles, almost like a narrow blade. *See* our remarks on the fitting of weapons. It is a very old observation that the murderer may use one weapon, and then substitute another belonging to the murdered man or woman, which he purposely stains with blood, in order to convey the impression of suicide. There were many who supposed this to have been done in the case of the alleged suicide of Abdul Assiz, the late unhappy Sultan of Turkey. It was said that his veins were divided by a sharp surgical knife or lancet, and then the scissors worn by him were stained with blood, as if he had done the deed. We shall return to this case presently.

C. You should *carefully examine the dress* of the wounded or murdered person. Where possible, and in the case of a corpse you can always spare the time, examine the outer clothing, and each successive layer of dress first, before cutting off or otherwise removing the coat, shirt, or other article of dress. Preserve, if possible, all the holes indicative of stabs, cuts, or other use of weapons—either by not destroying the clothes at all, or by slitting them up remote from the tear, or opening in the dress. In some cases, as of gun-shot wounds, the several layers might be removed together, by cutting round and outside the openings in the various articles of clothing, by a similar manœuvre to that recommended in the case of wounds. In the Schleswig-Holstein war, Mr. L. S. Little found a Dane wounded by a bullet through seventeen different layers of as many garments. The poor man had apparently worn all his wardrobe, just as the father of the Poet Coleridge is said to have worn the relays of shirts with which he was furnished by his wife ! The clothes should be preserved under lock and key, with an appropriate label or inscription. In the case of Rynwick or Renwick Williams, tried in July, 1790, well known by the appellation of "The Monster," for assaulting Ann Porter, spinster, the indictment set forth that he did "tear, spoil, cut, and deface her garments, viz., one silk gown, value 20*s.*; a pair of stays, value 5*s.*; a silk petticoat, value 5*s.*; one other petticoat, value 5*s.*; a linen petticoat, value 5*s.*; and a shift, value 5*s.*" It would appear that Miss Porter received a wound on her hip, for *Mr. Tomkins*, a surgeon who attended her, deposed, "that the wound was made with a sharp instrument, which appeared to be the same that had injured the clothes. He had examined the clothes, all but the shift; the first part of the wound was only through the skin, the middle part was at least three or four inches deep, and then it ran about three inches more through the skin only—the whole length of the wound was between nine and ten inches. Part of the blow was below the bow of the stays, if not, it would probably have pierced even the abdomen. The blow or wound must have been with great violence." It is somewhat strange that the prisoner, who was tried a little later for eight other similar assaults, and convicted on four, should not have been tried for the wounding. The object probably was to save his life. He was tried under an Act passed in the 6th of King George I., against cutting and defacing of garments, &c., and Mr. Justice Buller, though he said this was the first case tried under the Act, said also that it was notorious such cases were very common.

N.B.—Although a shot or knife wound must usually traverse clothes to reach a covered part, yet fatal injuries may be inflicted, and leave no mark on the dress. *See* Illustrative Cases.

D. *The surroundings of the wounded person should be carefully examined.* We have before advised you to make a rough sketch of the position of the body in the case of murder. *See* Fig. 1, page 7, and Taylor, *loc. cit.*, vol. i., p. 491. But if called to a wounded person, even if you have no time to make a sketch, you should note carefully the position in which he is. If there are bystanders, inquire if the person or corpse have been moved. Examine the surrounding furniture and the floor for marks of a struggle [disordered or broken furniture], and for spots of blood. It might be well in many cases to cut out the marks of blood with a sharp knife if on wood, and to scrape them off or dig them up if on stone, bricks, or earth. If the stains are on bedding, [linen sheets, or blankets, towels, &c.], these articles should be taken away entire and examined at leisure. In giving evidence on such matters it is best to confine yourselves to simple matters of fact. In an instance recorded by Dr. Taylor, a medical witness said that there were *evidences of a severe struggle.* On being cross-examined, however, it appeared that a broken glass and an overturned chair were almost the only facts on which he based this assertion. In the case of *Reg.* v. *Gardner*, the sweep's wife had numerous cuts in her fingers [figured at page 492 of Dr. Taylor's book], such as would be caused by a person taking hold of a knife in order to try and wrest it from her assailant.

The importance of noting minute circumstances is well shown by a case recorded by Dr. F. Ogston of Aberdeen [" Med. Times and Gazette," January 20, 1877 ; *see* also Taylor, *loc. cit.*, p. 504, vol. i.]. The prisoner *Davidson* was tried for murder before the Aberdeen Court of Justiciary, April, 1855, and the origin of certain wounds on the head of the deceased, turned on the question of the presence or absence of nails at the head of a bed. Lord Deas, the judge, remarked :—" *A medical man, when he sees a dead body, should notice everything.*" There was reason to believe that the nails had been driven in after the infliction of the violence, and even after the post-mortem examination ; and although some medical evidence went to show that the wounds might have been accidental, yet Dr. Ogston showed that there was no blood on the bed-stock where the nails were said to have been, as on the theory of the defence there should have been. Again, the distance of the nails from one another and the distance of the wounds do not seem to have coincided. It does not appear that there were any *actual* measurements of the distance between the wounds. Dr. Ogston justly says :—*Not only measure the wounds themselves*, but also the distance *apart, when there are two or more wounds on any one region of the body.* Had there been sufficient attention to the state of the bedstead the prisoner would have been convicted.

You may be asked in some of these cases, how far could a person with such-and-such a wound, whether suicidal, accidental, or homicidal, run, walk, or crawl after the reception of the wound ? We would suggest to you not to be too dogmatic on such a point.* We will give two cases to illustrate the need of caution in framing your reply. A young woman in the neighbourhood of Uxbridge is confined of a child at or near term. She loses so much blood that her own clothes, a number of towels and shifts, and the bed and bedding, and floor of the room, are soaked with it. She contrives, however, to drop from a bedroom window, a height of twelve or fourteen feet, to walk at least a couple of miles (for she was tracked by the blood so far), and, it is believed also, to walk all the way to London—some nine or ten miles at the least—and when seen by one of the Authors four days after, appeared little the worse for it. She also carried a bundle. It is possible she may have had a ride in a market-cart part of the way. Again, a man is wounded in the skull [parietal region] by a bolt used in rivetting. The force of the blow stuns him, fractures his skull, so as to expose and lacerate the dura mater, and allows a portion of the brain to escape. There was considerable hæmorrhage. Yet as soon as he recovered consciousness (in about a quarter of an hour) he walked a distance of more than two miles to the London Hospital, and told his own story. This case occurred in Mr. Curling's practice, but was seen by one of the Authors. The man recovered, too, in spite, first of erysipelas, and then of hospital gangrene.*

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* We can scarcely do better here than quote the sensible and manly advice of Sir William Blizard, formerly surgeon to the London Hospital. He said to his pupils, " Be the plainest men in the world in a Court of Justice ; never harbour a thought that if you do not appear positive you must appear little and mean ever after ; many old practitioners have erred in this respect. Give your evidence in as concise, plain, and yet clear a manner as possible ; be intelligent, candid, plain, and just, never aiming at appearing unnecessarily scientific ; state all the sources by which you have gained your information. If you can, make your evidence a self-evident truth ; thus, though the Court may at the time have too good, or too mean an opinion of your judgment, yet they must deem you an honest man ; never then be dogmatic, or set yourselves up for judge and jury ; take no side whatever, be impartial, and you will be honest. In Courts of Judicature, you will frequently hear the counsellors complain when a surgeon gives his opinion with any kind of doubt, that he does not speak clearly ; but if he is loud and positive, if he is technical and dogmatic, then he is allowed to be clear and right ! I am sorry to have it to observe that this is too frequently the case." " London Medical and Physical Journal," vol. xxi., p. 403. Quoted in a note to Beck, p. 961. Sir William Blizard was justly considered one of the first surgeons of his day.

E. *Any weapons that are shown you, or which may be found in, or upon, or near, the body of the wounded person, should next be carefully examined,* and if possible compared with the wound or wounds then and there. In the case of a dead body this is of course easy. Many discussions have arisen as to what constitutes a *weapon.* Webster defines it as "an instrument of fence ; something with which one is armed to kill or injure another, as a sword or musket, &c." Formerly there was much legal discussion on this point. There could, of course, be little doubt as to instruments of warfare ; so that all projectile-throwers, slings, and bows and arrows, firearms of all kinds and sizes, both large and small, and plain-bored or rifled ; swords, spears, javelins, battle-axes, bayonets, daggers, &c. were clearly included. Nor was it easy to say that a common axe or a surgical knife were not weapons. But exception was taken to including stones and brickbats, sharp tools, such as awls, or chisels, or augurs, or hammers used in peaceful trades, and in one case to an iron hook at the end of a wooden arm, used by a one-armed man as a weapon, and, as it turned out, a very fatal one. You are not likely to be much troubled with these subtleties of law and philology, at least in England, for the words of the statute are now plain—"Whosoever shall, *by any means whatsoever,* wound, or cause any grievous bodily harm, to a person, &c." Yet, as Dr. Taylor remarks, the use of any weapon, that is, of any addition to what may be called the natural weapons or means of defence (the fists or feet) is considered an aggravation of the prisoner's crime, and the more deadly the weapon, as for example, a sharp and twisted stiletto, or a many-chambered revolver, the greater the offence. You may consult Henke's "Zeitschrift der S. A.," 1844, 1, 67, quoted by Dr. Taylor ; Foderé, and Orfila, and some of the older writers deal with this point at some length. The characters we have given in the introduction, of incised, lacerated, and other wounds, will assist you in forming a judgment as to the kind of weapon. *Incised wounds,* for instance, will usually be inflicted by weapons with *sharp* edges, such as knives, swords, two-edged cutlasses, and the like. A razor is a kind of knife, and so are most surgical instruments used in cutting. [*See* page 1047, note.] A *sharp-pointed* and *narrow*

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* The following, from Beck, is a case in point. At the Warwick Assizes in 1832, *John Danks* was tried for the murder of *Mary Green.* After conviction he confessed that he cut her throat with a knife in a hovel. The wound was 7 inches long, 3 deep, dividing the trunk of the carotid, and all the principal branches of the external carotid and jugulars ; yet in this state it appears that she ran 23 yards, besides crossing a bar-gate, 3 feet 10 inches high. At this distance at least she was found, and the criminal to the last denied that he had touched her, except in the hovel, where he left her for dead. A gentleman went over the ground after the trial, and it took him about thirty seconds. Scarcely any blood was observed in the intermediate space, and this is explained by supposing that she closed the wound with her cap, and also by holding down her head. Much blood had, however, flowed down her breasts, and lodged about the pubes. In the hovel, also, a large quantity was observed. "London Medical Gazette," vol. x., p. 183. Beck, p. 631.

instrument [long-bladed knife, bayonet, spear, poniard, rapier, &c., will produce *stabs* or *punctured wounds.* In these, if they traverse, as remarked before, the aperture of entry is generally larger than the aperture of exit, and its edges are sometimes *everted* [although the contrary might be supposed, and does sometimes occur] from the withdrawal of the weapon, when done rapidly. It is sometimes *assumed that wounds from broken glass cannot be clean-cut incisions, and must contain broken glass.* The Authors know that this is not always true. It is, however, in general correct to say, that *wounds from broken glass and broken china or earthenware are* generally *characterised by their great irregularity, and the unevenness of their edges.* Again, *punctures from a flint or sharp stone* are generally *lacerated and irregular.* The Authors know of a case in which a young lady suddenly sat down on and broke a crinoline steel, which penetrated the vulva and vagina, to a considerable depth, thus producing a lacerated external wound, and a deep punctured internal one, with copious and alarming hæmorrhage. Fortunately her father, who was a medical man, was close at hand. The cases given by Dr. Taylor, at pp. 471 and 472, were clearly not at all likely to be produced by broken glass, for one was a clean cut five inches long and one inch deep, laying bare the carotid artery; another, a clean cut, like that produced by a penknife (and one was found on the prisoner), about two inches long and one deep. But the Authors know of a case in which a chemist's apprentice in cleaning a window cut his wrist, and severed his radial artery completely. The wound was not very ragged, and it looked at first as if it might have been done by a knife. But there were other and slighter cuts on the fingers from the broken glass. They also know of a case in which a thief got his head right through a pane of glass of large size, and thus cut his throat; some broken glass was, however, found in the wound. At the Worcester Summer Assizes in 1838, says Dr. Taylor, a case was tried in which the deceased was said to have died from a small punctured wound of the chest, supposed to have been produced by a small skewer found near the spot. The wound, five and a half inches deep, had completely traversed the right ventricle of the heart, and had led to death from loss of blood. The defence alleged that the wound was produced by falling on a nail projecting from a tub. The surgeon, however, said that the wound was a clean cut one, whereas if done by a nail it would have been ragged. The 24th & 25th Vict., c. 100, which we have mentioned before, relieves medical witnesses from any very special responsibility as to the exact mode of production of wounds. But your own credit as surgeons and careful observers is at stake, and you may sometimes be able to prove the innocence of one prisoner, or the guilt of another, by a careful examination of a wound. Thus, says Dr. Taylor, Mr. Hancock was able by this means to disprove a charge of maliciously wounding made against innocent persons in January, 1853. A little girl, whilst sitting on or over an iron-grating, was said to have been wounded in the private parts by some person or persons pushing a toasting-fork, or some pointed instrument, through the bars from below. There were no marks of punctures, as there should have been with such a history, but only some slight laceration of the parts, such as she might easily have got by falling on the edge of the grating. There were also, to confirm this view of the case, some bruises on the thigh. Although the remark more properly belongs to the section of wounds on the genitals, it is perhaps not amiss to remark here, that the accidental breaking of, and falls on, *pots* *de chambre*, not seldom inflict somewhat severe wounds on the female genitals. It is often difficult to say whether the fist, or a stone, or some blunt instrument have inflicted lacerated and contused wounds on the scalp. Sometimes a fall on stones, gravel, &c., may inflict injuries which may appear to have been caused by a blow. *Gravel, sand, mud, or fragments of grass, sawdust, &c., found in a wound, may* throw light on this question. We have before remarked that *when the skin is tense, comparatively blunt things* (edge of a pewter-pot, edge of a fender, the knuckles, &c.), *will cause a tolerably clean cut wound in some situations* (edge of orbit, zygoma, side of head, &c.). The tension and elasticity of the skin will modify the shape of a wound. Hence the wound of a bayonet, dagger, or bullet, &c., often looks smaller than the weapon or missile which produced it. The Act of Parliament referred to above makes it immaterial whether the wound was produced directly by a weapon, or indirectly by any violence on the part of the assailant. We mean immaterial as regards the conviction of the prisoner, for as regards his sentence, it is a very different thing whether the prisoner merely pushed the deceased, so that he or she sustained a fatal fall, or whether he aimed direct at the dead man or woman with a five or seven chambered revolver, and fired once or several times. In *Reg.* v. *Dodd* (Shrewsbury Summer Assizes, 1853), Justice Coleridge held, that if the prisoner knocked the deceased down, that it would make no difference whether the deceased died from the fall on a stone floor, or from injury directly produced by the stone which was thrown at him. The death took place a week after the injury, from inflammation of the brain consequent on fracture of the skull.

Do not be too positive that the knife or other weapon, even though it fits the wound, is the *identical* weapon. Be satisfied with saying, "*Such a knife* [or other weapon] *might have produced the fatal injury.*" Taylor gives the following case from Schwörer [" Lehre von dem Kindermorde."] " A man stabbed another, and a knife with perfectly entire blade was produced as circumstantial evidence against him, the surgeon stating that the wound was caused by *this* knife. A year after an abscess formed where the wound was, and the broken point of the *real* weapon was discharged from it. Hence the knife shown in Court could not have been the weapon used."

When a weapon is brought to you do not wipe or cleanse it. Reserve it for further examination [for *blood* in the case of knives, and other cutting or stabbing instruments, *see* chapter on Blood Stains, pp. 579-606] ; and for evidence as to recent discharge or otherwise in the case of Firearms. Note particularly the maker's name, or any marks or numbers in the case of knives, and other weapons. Make a tracing on paper with a pencil of the shape of the weapon—measure it. In the case of firearms, handle them discreetly, *and do not point them at any one.* Many accidents have arisen from inattention to this.

In *Reg.* v. *Skelton* (Carlisle Spring Assizes, 1858) an old man, it was proved, died from fractured skull. On the left side of the crown of the head there was a square-shaped depressed fracture, about the size of half-a-crown piece, the bone being depressed or driven in. In the prisoner's house was a hammer, with a square face, the corners being slightly rounded ; it fitted the wound described. The other end of the hammer fitted another smaller wound. There was, however, no blood on it. On an angular stone found near there was blood, and one white human hair. The prisoner was acquitted. It was suggested that the 'caulker' or square piece of iron at the heel of a horse-shoe might have produced the injury. There was, however, no trace of any other part of the horse-shoe. We have known the edge of a horse-shoe produce a scalp wound which resembled a clean cut, except that the edges were more rounded and less sharp. Fracture also has been brought about in this way. As we stated before, teeth, hands, and feet, are not usually considered weapons in law. At the Nottingham Assizes, in 1832, it was sought to put artificial arms and legs on a similar legal footing. The prisoner had used an iron hook on a wooden arm. The objection was overruled. But in the similar case of Benson, tried at the Central Criminal Court for a ferocious assault, in November, 1871, the Deputy-Recorder, in passing sentence, said:—"That having the hook screwed to his [left] arm the assault, though very brutal, was *less heinous* than if it had been done with a knife procured for the purpose."

In the event of finding *hairs on weapons* [which is a pretty common occurrence, *see* Taylor, pages 476-7, 509, &c.] you should examine them carefully to see if they are *human hairs*, or those of some domestic or wild animal. They should, if human, be compared with hairs from the victim, and also with those of the assailant's head, &c.

Hairs and portions of dress from the murderer or assailant are often found in the *hands* of the victim. A similar examination and comparison must be made here.

The specimens should be cleansed in turpentine, and mounted in Canada balsam; so preserved, their dimensions and appearances are little altered, and micrometric measurements can be easily made and verified. Careful attention to the caution given in the chapter on Blood-Stains will prevent your mistaking rust-spots or grease for the latter.

Many authors on Medical Jurisprudence (including even Dr. Taylor) enter into definitions and explanations as to *direct* evidence (or that from witnesses who have seen the deed, or heard the words, cries, &c.), and *circumstantial* evidence, such as that afforded by the wounds, blood-stains, dress, weapons, &c., or the *presumptive* evidence founded on all these. We do not propose to encumber our pages with these. Nearly all the evidence given by medical witnesses in the case of wounds, in trials for murder, belongs to the latter classes. You, as medical witnesses, depose to the facts or circumstances of the case. It is for the judge and jury in most cases to draw the conclusions. Yet you must not omit to guide their decisions by pointing out such obviously striking facts as may at once, from their nature, weigh heavily for or against the accused. For instance, "it is recorded in the life of that great surgeon, Sir Astley Cooper, that when called to see *Mr. Blight*, of Deptford, who had been mortally wounded by a pistol-shot in the year 1806; he inferred from an examination of the localities that the shot must have been fired by a *left-handed* man. The only left-handed man near the premises at the time was a Mr. Patch, a particular friend of the deceased, who was not in the least suspected. This man was, however, subsequently tried and convicted of the crime, and made a full confession of his guilt before execution." Taylor, *loc. cit.*, p. 505; *see* also *ibid.*, p. 493. In the case of *Sellis* [*see* Illustrative Cases] the prisoner was found to be *ambidextrous.* So in other cases. Dr. Taylor mentions one of a *wood-carver.** Although you had better generally leave gunsmiths and armourers to enter into technical details regarding weapons with which they are familiar, we advise you to learn all you can as to weapons in any given case in which you are concerned. As we shall show you, under Gun-shot Wounds, and as the anecdote above proves, the conviction or acquittal of prisoners often turns on purely technical matters.

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* The evidence as to *right or left-handedness* in a given individual, must in general be a matter of testimony of those who know the person. Dr. Struthers ["Anato-

F. As regards the *person, dress, and weapons of the suspected assailant or murderer, the same principles must guide you in the examination* as are laid down *for your guidance in the examination of the victims.* On the *person* there may be marks of injuries inflicted in the struggle, when the person assailed has made resistance. So that a murderer may be cut about the hands or face, or stabbed in some part with the same knife or other weapon he has used to attack. He may even have gunshot or bullet wounds, or, when firing very close, may be blackened with the powder. Murderers who wish to gratify revenge, or who are actuated by jealousy, and lunatics who first murder and then commit suicide, often shoot or stab themselves. So with patriots and conspirators. You remember Martial's epigram [xiv., lib. i.] about Arria, the brave wife of Pætus Cecinna of Padua.

> " Casta suo gladium cùm traderet Arria Pæto,
> Quem de visceribus traxerat ipsa suis ;
> Si quâ fides, vulnus, quod feci, non dolet, inquit :
> Sed quod tu facies, hoc mihi, Pæte, dolet ! "

In modern times there are many examples of combined murder and suicide. To quote one only at present. In April, 1799, the [Rev.] *James Hackman* was indicted at the Central Criminal Court for the wilful murder of [Miss] *Martha Ray*, by shooting her with a pistol just outside Covent Garden Theatre, after the play. She died almost instantly. Her "wound was received in front of the head, in the centra coronalis, and the ball was discharged (came out) under the left ear." No sooner had he done this, than he shot himself, also in the head, with another pistol. His wound, though severe, was not mortal, though he bled very much. He recovered sufficiently to be tried in a few days. [It happened on the 7th April, and the trial was in the same month.] No sooner had he done the fatal deed, than the "phrenzy," as he called it, was over. From a letter he wrote, and his confession at the trial, it would appear that jealousy was the motive. He was sentenced to death.

A careful examination of the *direction* of the wounds is of course important here. The murderer's hands, face, or some other part of the body may bear the marks of nails and teeth. These should be carefully examined and measured. It is very often a good plan to take a wax or clay mould of the teeth and nails of the deceased. Ordinary beeswax (still better if with some oil or tallow), modellers' clay or plaster of paris,

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mical and Physiological Observations,"] observes that the viscera in the right half of the body are heavier than those of the left half, and Gratiolet says the left brain is better developed. The majority of mankind, either by instinct or education, are *right*-handed. In such, the muscles of the right upper extremity are rather better developed than those of the left. The right chest is also bigger. In some few left-handed persons there is transposition of the viscera (the converse is not always true), in most the left upper extremity and thorax are more muscular than the right arm and chest. In some cases of *left*-handedness, the right half of the brain has been said to be much larger than the left. *Ambidextrous* persons present the greatest difficulty. There seems no proof of Hippocrates' assertion that women are never ambidextrous—rather the contrary.

or even gutta-percha softened in warm water, will do for this. Sometimes the victim, as mentioned before, has grasped hairs, or bits of skin, from his or her assailant. These must, of course, be carefully examined and compared (*see* before, and chapters on Examination of Hairs, &c.).

In one case, the murderer *dropped a tooth-plate* in the scuffle, and by the peculiar make of this and its fit, he was discovered.

Of the careful examination of *weapons* we have spoken before (p. 1090), and shall return to the subject under Gun-shot Wounds. Whilst speaking generally, however, the following cases from *Sonnenschein* ("Handbuch der Gerichtlichen Chemie," p. 379, &c.), are very instructive. The first is as follows: "F. 67, 65. A buckshot was extracted from a wound. This missile had not only the precise size of several others, found in the possession of a wounded person, but also the precise chemical composition of these, which was so far remarkable, as not only was there lead, but a very unusual quantity of antimony in these shots." Again, "G., 183, 66. A poacher shot at a gamekeeper or forest-bailiff; the wad, or rather paper, in which the shot was wrapped was found, and consisted of a sort of red blotting-paper of peculiar make. In searching the poacher's house a quantity of similar paper was found, which, with other evidence, settled the case, and the poacher was convicted." Other cases are reported, in which, in the prisoner's pockets, or at his lodgings, a torn newspaper has been found, corresponding with the paper used as wadding.

The dress of the suspected person must be carefully examined for blood-stains. *See* the chapter on that subject, page 579. In the recent Hungerford murders of police, Drs. Tidy and Major found that the poachers who were suspected had not only washed the blood-stained parts, but had covered them *over with red-lead.* This, although it increased Dr. Tidy's difficulties, did not prevent the discovery of the blood, nor even the application of the spectroscopic tests. Even so simple a reagent as distilled or soft water would dissolve the blood-colouring, and not affect the red-lead, except very slightly. It may not be amiss to mention here, that the use of soap or alkalies (as in washing blood-stains) does not really prevent even the use of the Guaiacum test of Van Deen and Day. For if we find no reaction, or that soap has been used, it is sufficient to acidulate with lemon-juice, citric or tartaric, or acetic acids, when the sapphire blue comes out almost as well as when no soap has been used. In some cases quite as well. It does not seem even that red corpuscles are essential to this reaction. If the serum, fibrin, or leucocytes, are present, the reaction is obtained. You may test this by filtering out the red corpuscles, or if too small for this, letting them subside, and testing the serum, or washed coagulum.

Foot-prints must, of course, be carefully examined and compared with the feet or boots (as the case may be) of the suspected person or persons. *See* page 670. In the Hungerford case wax was used to take the impressions, but we think stearin or paraffin better. Examine prisoner for right or left-handedness, also his dress, &c.

Of Gunshot Wounds, or Injuries from Firearms, Fireworks, and other Weapons, Missiles and Explosives.

Of the Weapons themselves, and of the General Theory of Projectiles as bearing upon Practical Points.

Although the laws which govern the flight of projectiles *in vacuo*, are tolerably simple, being founded, as we shall presently see, upon the Newtonian laws of motion and the effects of gravity; yet the consequences of the resistance of the air, of differences in the shape and weight of the missile or projectile; of the amount of gunpowder or other substance which is to furnish the impelling or propelling power; and the effects of the accuracy, and amount of rifling of the bore of the weapon, as well as of the length of its barrel, or, in other words, of the tube; all tend to complicate the practical problems. And the resistance of the air may be still farther modified by the pressure and velocity of the prevailing winds; whilst the degree to which the missile or shot *penetrates* depends not only on its mass and velocity or *momentum*, but upon the nature of the resisting material. So that in rifle-shooting, and gunnery of every description, we really have complicated problems. All that we can pretend to do for our readers, is to glean from practical works some few of the results of experience, and to set these alongside of the theory. This is necessary in order to a right understanding of the peculiarities of *gun-shot wounds*. Under this term we include the wounds and injuries caused by the discharge of every kind of firearm [and even of an air-gun]; from the tiny saloon pistol, which is little more than a dangerous toy, to the "Woolwich Infant," or 81-ton gun, or those still larger monsters of 100 and 200 tons, which Armstrong and Whitworth in England, Krupp in Germany, and Dahlgren in America, are said to be making. We cannot even enumerate all the names of these weapons, or of the missiles they discharge, nor is it necessary.[*] In order to simplify the matter for practical purposes, we may first divide the *weapons* themselves into two or three classes. The first broad distinction is into *firearms proper*, or those in which *the missile is discharged from a tube* of longer or shorter dimensions, including all the weapons mentioned in the previous note; and *fireworks* or *missiles of the rocket* and *torpedo class* in which there is no tube, except that of the cartridge, and the whole weapon, so to speak, is discharged. In real truth, however, the distinction is somewhat arbitrary, since in the rocket class, there is a tube, but this goes with the shot or shell or other contents, at least a part of the distance. As these will detain us but a short time, we will deal with them first. *Rockets* are of great antiquity, and are said to have been invented by the Chinese. Tippoo Sahib used them against the English. Sir W. Congreve first made them of iron, and under the name of *Congreve Rockets*, they were long used in the British service. He employed shell-heads, and heads filled with inflammable composition, for incendiary purposes. All these rockets were kept head foremost in their flight, by the use of a stick which acted on the same principle as the feathers of an arrow. Grooves are now made in the side of the rocket, and in order to dispense with the use of a stick, a rapid rotation is imparted to it by means of a triple shield at the base, the invention of Mr. Hale. The patterns now used in the British service are 9-inch and 24-inch. Though they can be fired from the ground, they often are fired from a tube. Used to frighten horses, and to set fire to powder magazines and other erections, they are generally filled with very explosive materials, small shells which splinter in exploding, and easily combustible substances. The injuries inflicted by them on persons will be (*a*), burns ; (*b*), lacerated and contused wounds ; (*c*), penetrating or perforating wounds. These will not materially differ from those inflicted by firearms proper. Besides these, there are *life-rockets*, used to send a line to a ship and establish communication between wrecked ships or those in danger and the shore, and *signal* rockets, filled with coloured stars and other contrivances for giving notice of their presence.

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[*] Artillery, a general name for heavy guns; Arquebuse; Basilisk; Blunderbuss; Bombard; Caliver; Cannon, a general name for large guns, smoothbore or rifled; Carronade; Carbine, a name for a short musket or rifle; Culverine; Falconet; Field-piece; Fire-lock; Fowling-piece; Fusil; Gun, a name given alike to duck-guns and other sporting weapons, and to heavy ship and field-pieces, and the large guns used in forts; Gingall, or Jingall; Howitzer; Lintstock, or Linstock; Matchlock; Mitrailleuse; Mortar, used to fire bomb-shells, &c.; Musket; Musketoon; Paixhan [gun]; Pistol; Piece; Petercro; Petronel; Petard; Pederera; Rifle [the Minie, Chassepôt, Needle-gun, Enfield, Jacob, Martini-Henry, Lancaster, Whitworth, are the principal modern forms]; Repeater; Revolver [forms of pistol combinations, of which Adams', Colts', and Dickinson's, are some of the best known]—are a few of the names.

Amongst the missiles, shots, and explosive bodies, either discharged by these, or independently, are, Orsini and other Bombs; Shell and Shot of all sizes and shapes, solid and hollow; such as Ball, Grape-shot, Canister-shot, Chain-shot, &c.; Bullets of all sorts and sizes [spherical, conical, hexagonal, &c., &c.]; Slugs; Grenades; Carcass; Rocket; Congreve; Shrapnell; Langrange; Torpedoes; Small-Shot; Cartridges of various kinds, &c., &c.

Torpedoes are cases filled with explosives, so contrived as to explode when struck by a ship's keel, or at a given signal by a time-fuse, or by an electric spark. Essentially destructive weapons, they are adapted chiefly for defence. They have been little used in actual warfare. The case of the *Bremerhaven Explosion*, to be mentioned presently, showed almost diabolical ingenuity in adapting clockwork to the atrocious purpose of destroying a passenger ship and all her cargo in order to get the insurance. If a torpedo did not utterly destroy a ship's crew, the injuries would consist, as in the case of rockets, of burns ; lacerated, contused, and punctured wounds, which, as in the case of *wounds* from *fireworks* and *explosives* generally, are aggravated in many cases by foreign bodies, particles of gunpowder, or of the explosive composition, bits of paper and paste-board, particles of wood, or of clothing, &c., &c., which tend to irritate the wound, to promote unhealthy inflammation, and retard the healing process. [Consult the articles "Rocket" and "Torpedo," in the "English," and "Popular," and "Chambers'" Encyclopædias.]

Returning to our first division of *firearms* proper, these may be conveniently divided into easily portable or hand weapons [pistols, revolvers, carbines, muskets, rifles, fowling-pieces], and *artillery* or larger weapons, used for ships, fortifications, and field-service, which require several men or horses to carry them from place to place. [Guns, cannons, mortars, howitzers, &c.]

In the first class, or weapons carried in the hand, we have in all what may be called a body, and a soul or essential part. The body consists of a stock, and in many military weapons, of a bayonet, and of sundry accessories. The soul consists of the *tube*, which holds the charge, and of the lock, trigger, and other contrivances, for discharging the missiles.

This *tube* may be only from three or four to six inches long, as in many pistols, or it may vary from two feet to six, or in some very old weapons, to seven or eight feet, as in carbines, rifles, guns, &c. The interior of the tube may be a "smooth bore," or it may be *grooved*, as in the case of rifles; and in these weapons, in modern times, the grooves do not run straight, but are curved in a spiral form, making from $\frac{1}{2}$ or $\frac{3}{4}$ of a turn to several complete turns in the course of the length of the tube. This spiral or twisted arrangement of the *grooves* is called *rifling*.* It gives the name to the Enfield, Minié, Whitworth, and other *rifles*, and gives great precision of flight to the bullets. The bore or shape of the tube may be more or less *circular*, as in old guns; *elliptical*, as in the *Lancaster* rifles and cannon; *hexagonal*, as in the *Whitworth* rifle; or *irregular*, as in many old and badly made weapons. As regards the method *of loading*—in former times all weapons, whether sporting or military, large or small, were loaded at the *muzzle*, or further end of the tube (point of exit); now-a-days, a very large number of fire-arms are what is called *breech-loaders*, that is, the charge which now generally consists of a *cartridge* of some kind, containing both powder and ball, is put in at the near end of the tube; in other words, in a long gun, near to the shoulder, and, of course, close to the lock and trigger. The above remarks, as to smooth and rifled-bores, and as to muzzle and breech-loaders, apply to both large and small sizes of fire-arms,—to pistols as well as to cannon of enormous size. As regards the *mode* of *firing*, the most ancient weapons were *matchlocks*. A light was first obtained, either from flint and steel, or from a torch, or in forts and ships from a fire kept burning. A sulphur match lighted from this was used to discharge the weapon. Although *flint-locks* were used in France as long ago as 1630, it does not appear that the English adopted them until 1677, or thereabouts. A few weapons of this description, chiefly long duck-guns, or ancient carbines, are still to be met with in country places. Such guns are sometimes given to boys employed in *bird* keeping. Accidents will sometimes happen from too much powder being used for the *priming* of such weapons.

At the beginning of this present century, the weight of the English musket and bayonet was 11 pounds 4 ounces. The bullets used were 16 to the pound. The charge of powder [F.G.] 6 drams avoirdupois ($\frac{3}{4}$ ounce), and the diameter of the bore was ·753 inch. The bullets were, of course, spherical, and the locks were flint-locks. In 1807, the Rev. Mr. Forsyth took out a patent for a priming with a fulminating composition, which has been superseded by the percussion caps now used, in which fulminate of mercury, or some other fulminate is used, as well as chlorate of potash, ground glass, &c. The superiority even of the first percussion muskets was strikingly shown in the trials instituted in 1834. Six thousand rounds were fired from six specimens of each description of arm, and the experiments conducted in all weathers. Out of 6,000 rounds from the *flint* locks, there were 922 mis-fires, being 1 in 6½, whereas from the percussion musket there were only 36 misses in 6,000 rounds, or 1 in 166. Besides that, the precision of fire was greater. The success of modern percussion caps is still more striking. The percussion caps permitted also of less powder being used, the 6 drams being at once reduced to 4½.

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* The *spaces between* the grooves are called *lands*—these, in Major Nuthall's rifle, have rounded smooth edges.

The *pull of the trigger* was also reduced from 12 or 13 pounds (it has been known to be nearly 27 pounds in some old weapons) to some 7 pounds or less. In 1800 the 95th (British) Regiment, now known as the Rifle Brigade, were armed with a rifle, which weighed, with the sword, about 10½ pounds, or 9½ without it. They were sighted for from 100 to 200 yards, and the barrel had seven grooves, which made a quarter of a turn in the length of the barrel (2 feet 6 inches). The entire length of the rifle (stock and all) was 3 feet 10 inches, diameter of bore ·623. The locks were very well made and provided with detants to prevent the nose of the sear from catching at half-cock; they had also bolts to prevent them from going off accidentally. The ball was spherical, and rammed in with a mallet in loading; this was afterwards dispensed with, and greased patches introduced." *

Baker, the maker of these rifles, admitted that 200 yards was the greatest range he could fire at with any certainty. "I have," he says; "fired very well at times at 300, when the wind has been calm." The *Brunswick rifle*, introduced in 1836, weighed 11 pounds 5 ounces with bayonet: its barrel was 2 feet 6 inches; bore ·704 inch. It had two deep spiral grooves, completing one turn in the length of the barrel. The bullet was spherical and belted; its diameter ·696 [or $\frac{8}{1000}$th of an inch less than the bore], its weight 557 grains. The ball was wrapped in a linen patch, dipped in grease, the bullet and cartridge were thus obliged to be kept separate. This weapon readily fouled after a few times firing. The belts on the ball were objectionable, from causing too much friction in passing through the air. The Enfield Committee reported that all firing beyond 400 yards was too wild to give a correct angle of its elevation.† In 1844 it was condemned at Antwerp as the worst of all tried on that occasion. But in 1842 the majority of our British troops were armed with a much worse weapon, the "old Brown Bess," as it was called. This had a smooth bore, ·733 inch in diameter, throwing a spherical ball 490 grains weight. It was tolerably effective up to 150 or 200 yards, but its shooting was very wild. In fact, although very deadly when fired close to a person, almost all old firearms in common use by troops were very defective. So that Colonel Schlimmbach, of the Prussian Artillery, calculated that during the wars of the first Napoleon, a man's own weight in lead [musket-fire], and ten times his weight in iron [cannonades], were consumed for each individual placed *hors de combat*. At Vittoria, on June 21st, 1813, some 3,675,000 ball cartridges were issued to the British troops. Now only 8,000 out of 90,000 of the enemy were killed and wounded. So that only one musket-shot in 459 took effect, if we exclude the 6570 rounds from the 90 pieces of artillery. Including these, probably only 1 in 800 of the bullets took effect. With "Brown Bess" at the Cape in August, 1851, a patrol expended 80,000 ball cartridges in killing or disabling twenty-five naked savages, or 3,200 rounds to each Kaffir! [Hans Busk, "The Rifle, and How to Use it," pp. 17, 18.] The Minié [called after its inventor, Captain Minié, was a great improvement on these rifles. This had a cylindro-conoidal bullet, with a square base, and two deep grooves above this. There was an iron cup or plug introduced at the base, to cause expansion, and prevent the gases from escaping through the lead. The ball weighed one-half more than those used by our soldiers. There were four shallow grooves in the rifle; and 2½ drams of powder were ample. Captain Minié himself could hit a man with it at 1,420 yards three times out of five shots. The ball entered with the point, and at 1,500 yards would penetrate 2 inches deep into poplar wood! Colonel Thouvenin invented a *carbine à tige*, or pillar-rifle, with a deeply-grooved ball. When this ball was dropped in, it received several sharp blows with a ramrod, which effaced the grooves, and fitted it closely; thus diminishing the *windage*.* As the *pillar*, just mentioned, supported the ball during this operation, the powder could not get caked. At 1,000 yards, with 1¼ drams (avoirdupois) of powder, the bullet from this would penetrate six or seven inches into heart of oak! However, this, and the use of the iron plug in the bullets were found awkward, lead being left behind in the barrel. Our space will only allow us to describe very briefly one or two other well-known and celebrated weapons. Two rifles have been known, since 1853, as the "long," and "short," *Enfield rifles*. The former had three, the latter five grooves in the bore. The *long Enfield* had a barrel of 39 inches; its bore was ·577 inch; weight 4 pounds 2 ounces (with bayonet, 9 pounds 3 ounces); its length altogether 6 feet 1 inch, or without bayonet, 4 feet 7 inches. The regulation charge of powder 2½ drams, F. G. Weight of bullet 530 grains; of 60 rounds of ammunition 5 pounds 3 ounces 11 drams. An ordinary marksman can make good practice with it at 800 yards; but in skilled hands still greater ranges are attainable. The barrel of the short Enfield was only 2 feet 9 inches. Its trajectory for 820 yards 2° 57′; for 1,850 yards, 10° 50′. In a range of 500 yards its trajectory has been said to be of the height of 15 feet, or about double that of the *Whitworth* rifle, but, according to others, the trajectory † of the Enfield has been shown to be 15·01 feet, that of Whitworth's 13·18 feet. The elevation of the Enfield being 1° 32′, that of the Whitworth 1° 15′. The three grooves of the long Enfield are ·115, or a little more than $\frac{11}{100}$ths of an inch in depth, and a little less than ¼ inch in depth. The rifling in the long Enfield makes just one half-turn from breach to muzzle. The Prussian *Zündnadel-gewehr*, or needle-gun, was remarkable for using a sharp needle (which often either bent or broke in use) for penetrating and firing the fulminating mixture in the cartridge. Its ammunition was dangerous; and the old weapon is not likely to be much longer used. The cartridge cases were consumed in this, as also in the French *Chassepot* rifle, in which a shorter and stouter needle was used. The Chassepot was lighter by nearly 4 pounds than the German needle-gun (which weighed about 12 pounds). It had a long range, and low trajectory; and in the war of 1870 the French were often able to open an effective fire at 1,500 paces, whilst the needle-gun was effective only at from 400 to 500 paces. The French dragoons, hussars, and chasseurs are armed with this weapon.‡ The ammunition is also lighter than even that of the *Martini-Henry*, to be mentioned presently, 90 rounds of the Chassepot being only 6 pounds 9 ounces, whilst the same number of the Martini-Henry weigh 9 pounds 5 ounces. *General Jacob's* new double rifle is thus described by him: — "Double, 32 gauge, 4 grooved. DEEP grooves of breadth equal to that of the LANDS, to take $\frac{4}{5}$ths of a turn in the length of the barrel, 24 inches long; weight of pair of barrels alone 6 pounds, *not less;* the ends of the lands to be rounded off at the muzzle; patent breach, no side vents; first sight *exactly parallel* to the bore [other details as to sights, &c., follow], exact diameter of bore in $\frac{1}{1000}$ths of an inch, ·529; of shell or ball, ·524; charges, $2\frac{1}{2}$, $2\frac{3}{4}$, 3 drams of powder." It can be fired either with percussion-tubes, and complete cartridge; or in the ordinary way. "In April, 1856, in a public official trial at Bombay, it was found that at 300 to 1,200 yards the flight of the shell was always point foremost, and the elevation, at the extreme range, inconsiderable. Very good practice was made. A box, filled with powder, was exploded at 300 yards. At 1,200 yards the shells, on exploding, tore out large fragments of the wall."

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* Hans Busk's "Handbook for Hythe," p. 123.

† The *angle of elevation* is said to be "the angle which the axis of the piece makes with the plane upon which it rests." We shall see presently, that it is necessary to fire high, in order to overcome the constant tendency of gravitation to overcome the initial force of the bullet.

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* *Windage* is the space or interval left between the bullet and the side of the barrel, or tube. It causes unsteadiness, by allowing the gases to escape alongside of the ball, and giving the latter a wobbling movement.

† The trajectory is the path of the bullet, or line of fire.

‡ "Popular Encyclopedia," article *Chassepot*.

Special construction of the *sights* is one of Jacob's peculiarities.

Whitworth's rifle has a polygonal bore [six-sided or hexagonal] of gauge number about 48 (·472 inch), length of barrel 39 inches, pitch of rifling one turn in 20 inches, or nearly two complete turns in the length of the barrel (in some of his rifles he has made six or seven complete turns). The precision of Mr. Whitworth's machinery is well known, $\frac{1}{5000}$th of an inch being most accurately gauged. His larger guns are made with equal or even superior accuracy. At Hythe the superiority of his rifle to the Enfield was reckoned as nearly 20 to 1. At 1,880 yards (120 yards over a mile) it drove its bullets into the target, whilst the Enfield failed to hit at 1,440. The Whitworth at 1,100 yards was almost on a par with the Enfield at 500; and when both had a range of 500, the superiority of the Whitworth was nearly 3 to 1. With the regulation charge of powder it propelled a bullet through 33 half-inch elm planks; and the missile was only stopped by a solid block of oak behind. The Enfield under similar circumstances only penetrated twelve of these planks. In 1866 the majority of the Enfield rifles in our army were *converted* into *Sniders*, or breech-loaders, in which the cock, and indeed the whole of the old arm was rendered available, except a small piece of the breech end of the barrel. Its ammunition is the "Boxer central fire metal cartridge." It is deadly at fair ranges; but the bullet is carried rather wide in a high wind.* In penetration it spreads and tears itself open.

The *Lancaster* rifle, like the gun on the same principle, has an elliptic bore. The "twist," which answers to rifling, is one turn in 32 inches. The bore he advises is ·498, length of barrel 32 inches; whilst an eccentricity of ·01 of an inch in half an inch is found sufficient to cause the bullet to spin on its axis to the extreme verge of its flight. The bullet is cylindro-conoidal; and the length, which was found to answer best, is one $2\frac{1}{4}$ diameters in length, with a *windage* of four or five thousandths, that is to say, just sufficient to allow of its being rammed home with very thin greased paper. It is slightly cupped at the lower end. The breech-loading principle has been adapted to the Lancaster bore in both rifles and large guns.

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* The force of the wind may be a question in other medico-legal inquiries. The table at foot of next page gives it approximately :—

The *Martini-Henry* rifle, with which the British Army is to be furnished in the future, is a breech-loader, with remarkably complete and rapid action. It is described and figured in the "Popular Encyclopædia," article *Musket*, plate cxxiv., fig. 13, &c. The ammunition for this arm is the Boxer-Henry, or General Boxer's short-chamber case (fig. 15, same plate), and Mr. Henry's bullet (of lead and tin) of ·45 inch diameter, and 480 grains in weight. The bullet is cylindrical, with a conoidal summit, has two grooves running round it, and is furnished with lubricators. The cartridge or case has a small *anvil* and percussion cap. To act on this *anvil* there is a small piston *striker*, which explodes the cartridge by the force of a strong spiral spring. The firing is very rapid. Twenty-five rounds in a minute (without taking aim) having been fired. The practice is good. It is less affected by wind than the Snider. And its penetration is very great. Its weight is altogether about nine pounds.

Another Mr. Henry, an American, has introduced another *Henry* rifle, a repeater, which allows of still more rapid firing. Mr. Pritchett, Colonel Nuthall, Colonel Colt, Westley Richards, Prince, Terry, Leetch, Daw, and other makers or inventors have all modified more or less the lock, bullet, cartridge, barrel, or sights of the rifle.

What are called *Carbines* are short guns, either smooth-bored or rifled. Sir William *Armstrong* has applied the principle of rifling so successfully to the large field guns which bear his name, that they possess a range of 9000 yards, or 5¼ miles. But this is a digression. To return to weapons which may be carried in the hand, the most portable of all are *pistols*. We must beg you to remember that a tiny bullet, weighing only a few grains, if fired at close range, with a sufficient charge, is capable of inflicting great damage, and of at least destroying an eye, if not of taking life. Even the toys made to fire a tiny (sparrow-shot), with a percussion cap, have been known to damage the eye. Pistols are now, however, made so as to be quite formidable weapons. A *Colt, Adams, or Daw's* revolver or Repeater is no toy. These weapons are furnished with from two to

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Miles per Hour.	Force in Pounds on Square Foot.	Character.
5	0·12	Gentle breeze.
10	0·49	A brisk gale.
15	1·11	
20	1·97	Very brisk.
30	4·43	High winds.
35	6·03	
40	7·87	Very high winds.
45	9·96	
50	12·30	A storm.
60	16·71	A great storm.
80	31·49	Hurricane.
100	49·20	A hurricane that tears up trees, and destroys all before it.

This table was originally drawn up by Mr. Smeaton, and published in the "Philosophical Transactions" in 1757. It will be found in most works on Meteorology.

twelve, or more, chambers; so that so many successive shots may be fired without reloading. In Colt's original weapon the ball was rammed down, by a peculiar compound lever, *home* on to the powder, and there was no wadding or paper of any sort. The hammer at full cock formed the sight. In his cavalry pistols the barrel was 7½ inches. A little wax over the nipple protected the charge from water, and after lying in the water some days it has been fired with good effect. A stock is supplied with some, which at once converts them into a carbine. In the action fought in India on June 18th, 1858, a body of 100 Hussars, provided with revolvers, effected tremendous execution upon overwhelming masses of the rebel army, headed by the Ranee of Jhansi. In a few minutes they left 400 dead upon the field. "The wound," says Hans Busk, "which a conical bullet from one of Colt's revolvers inflicts, is terrific, driving before it, as it does, a cylindrical plug of muscle or bone; the hæmorrhage or shock to the system is so great that death, in the majority of instances, usually ensues." Similar remarks apply to the Minié, Snider, and other modern bullets. The revolvers of Adams, Deane, Daw, and others, are little inferior, if at all, to Colonel Colt's weapon. One of Daw's charged with a quarter of a dram of powder [about seven grains avoirdupois] will send a bullet [of 50 to the pound, or 140 grains weight], through a fir plank one and a half inch thick. Most of these pistols are now made breech-loaders, and the cartridge is complete in itself in many of them, so that no cap even is necessary. The length of the barrel varies from 6 inches [or less!], in the saloon or pocket-pistol, to 18 or even 24 inches [holster-pistol]. It is said that so long ago as 1544 (reign of Francis I.) pistols were made at *Pistoia*, or Pistoria, twenty miles N.W. of Florence. The "dag" was a sort of clumsy pistol, mentioned by Elizabethan authors. This weapon was straight at both ends.

The hand weapons we have described are now almost invariably for military purposes, and also when used to murder or maim, loaded with bullets. Small shot, in which a number of little pellets (half an ounce, or more or less) are used in one charge, is now almost exclusively used for sporting purposes—small birds and the like. At very short distances (before the shots have time to scatter) these may act as a single bullet would, as we shall presently see. Except for the trouble they may give in picking them out, they are not of much importance to us in a medico-legal point of view. We shall, however, notice the wounds caused by them in their place.

We must pause briefly here to notice the various forms of *bullets.* You have, in reading the last few pages, noticed that some were spherical, and some of other figures. For the hexagonal bore of the Whitworth rifle, an hexagonal bullet is used. The various shapes which have been actually tried are very numerous. Two plates in Hans Busk's "Handbook for Hythe," plates viii. and ix., give 60 varieties. Of those actually used we may, however, state that the following are common forms:—(*a*) The spherical, in old-fashioned rifles, "Brown Bess," &c. This has been variously grooved and belted. (*b*) Cylindro-conoidal or conical top cylinders [acorn-like], Enfield, Snider, Boxer-Henry, &c. This was variously grooved and modified by Minié, the Zouaves, Chasseurs, &c. (*c*) Polygonal ones, of which Whitworth's hexagonal is the best type, and Westley Richard's octagonal. (*d*) Flask-shaped and other fancy ones. (Bersaglieri, Nessler, and obsolete Austrian ones). In practice, it has been found that the grooves cause too much friction in passing through the air; whilst the elongated bullet is far superior to the spherical. In General Jacob's experiments he found that both the cylindrical and conoidal portions of the bullet should be 1½ diameters long, so that the entire bullet will then be 3 diameters long. The Enfield is little more than 1½ diameters long, the Whitworth rather more than 2½ (some of his 3 to 3½ diameters long). If too pointed, the centre of gravity is thrown too far back. In small shots, and in bullets not spherical, or not all of one metal of known specific gravity, if you want to know the weight you must weigh them. The weight should be ascertained in grains. If, however, no bullet can be found, an approximation to the weight may sometimes be obtained, especially in spherical bullets, by taking the bore of the barrel and allowing a few thousandths of an inch for windage. The following tables may give some assistance in this matter. They are quoted from Mr. Busk's well-known works on the Rifle :—

TABLE I.—*Small Arm Cartridges.*

Nature of Cartridges.	Charge in Drams.	Number of Bullets to a Pound.	Diameter of Bullet in Inches.	Diameter of "former" in Inches.
Blank for all arms	3·50	—	—	·65
Lancaster Elliptic Rifle	2·50	10	·28	·65
Rifle Musket (pattern, 1853)	2·50	13·50	·55	·472
,, (sea-service, 1853)	2·50	13·50	·568	·5
Carbine (carbine bore)	2·50	20	·610	·59
Pistol (musket bore)	2·50	14·50	·680	—
,, (carbine bore)	2·0	20	·610	—

For lubricating purposes, bees' wax, or wax with $\frac{1}{12}$th part of petroleum or mineral oil, or (as formerly) a mixture of five parts of wax and one of tallow (kept at a uniform temperature of 230° F.), whilst the cartridges were making, are employed. Of course, the weight of missiles varies materially with their form. For whilst a spherical bullet for a rifle of 24 gauge weighs some 291 grains, a solid projectile of the cylindro-conical form would weigh 754 grains for the same barrel, or 7 grains more than a ball fitted for a 12-gauge barrel. As regards the quantity of powder required, it is said in theory ("Young's Nat. Philosophy") that $\frac{1}{5}$th or $\frac{1}{6}$th of the weight of the ball is the best charge; for battering, $\frac{1}{3}$rd. A 24-pounder, with 16 pounds of gunpowder, at an elevation of 45° ranges 20,250 feet, about $\frac{1}{5}$th of the range that would take place in a vacuum. The resistance is at first 400 pounds or more; and reduces the velocity in a second from 2,000 to 1,200 feet in the first 1,500 feet.

Table II.

Showing the diameters, in thousandths of an inch, of gun-barrels and of the leaden balls corresponding to the several gauge numbers together with the weight in grains of each ball.

Gauge No.	Diameter of *bore* in thousandths of an Inch.	Diameter of *bullet* in thousandths of an Inch.	Weight of leaden ball in Grains.	Gauge No.	Diameter of *bore* in thousandths of an Inch.	Diameter of *bullet* in thousandths of an Inch.	Weight of leaden ball in Grains.
5	·996	·991	1460	21	·612	·607	336
6	·943	·938	1237	22	·605	·600	324
7	·892	·887	1047	23	·598	·593	313
8	·848	·843	900	24	·590	·585	300
9	·813	·808	792	25	·580	·575	285
10	·787	·782	717	26	·572	·567	271
11	·759	·754	644	27	·565	·560	263
12	·739	·734	594	28	·559	·554	255
13	·727	·716	551	29	·551	·549	248
14	·705	·700	515	30	·546	·541	237
15	·687	·682	476	31	·541	·536	231
16	·673	·668	447	32	·536	·531	225
17	·659	·654	420	40	·496	·491	183
18	·649	·644	401	48	·472	·467	153
19	·636	·631	377	50	·467	·462	147
20	·625	·620	357	64	·424	·419	109

The force required to pull the trigger varies immensely. From hair-triggers, in which the force needed is almost *nominal*, to a pull, in some of the old weapons, of twelve to twenty or thirty pounds. An old "Brown Bess" has been known the *pull* of which was thirty-one pounds! This, as we shall presently see, makes a great difference in *precision of aim*, and, therefore, is worth study in criminal cases. An excess of powder again increases the tendency to *kick* or recoil.

The *sights* of hand fire-arms vary, from the trigger, in the original "Colt," or none at all, as in some old weapons, to the elaborate contrivances of some modern rifles, which include telescopes with achromatic lenses, furnished with fine wires, or spider threads, to intersect the object aimed at. Whatever contrivances a weapon is furnished with, except perhaps the telescope, a good shot will test the "sights" for himself, and very probably alter and correct them. Correct aim, such as that mentioned by Sir Charles Shaw in the "Times" of January 1, 1852, is only to be acquired by constant practice.* Yet it not unfrequently happens that the first time a gun or pistol is taken in hand a correct aim is obtained, though by pure accident perhaps. *At the distance of* 1,000 *yards, a man of ordinary stature presents a mark* little more than the $\frac{1}{12}$th of an inch in height, or the size of this letter ı; at 1,100 yards a target 25 feet square, with a 6 feet "bull's-eye" marked upon it, would be of this size ■; the bull's-eye this ●; and a man by the side, 6 feet high, this ,. At 50 yards a man 6 feet high is reduced to 1 inch, at 100 to ½ an inch, at 200 to ¼ of an inch, at 400 to ⅛th of an inch, and so on. Different statements are made on this point. Captain Thackery, for instance, states that the height of an infantry soldier at 325 yards is 2 feet, or more than ⅓rd of his actual size; but this certainly seems incorrect. Colonel Wilford says, from actual trials: "At 50 yards off he could name any man in his own regiment, as at this distance there is *complete identification*, for the age, complexion, height, and figure of a man can be determined." Compare, on this point, the remarks as to personal identity at pp. 639 and 640. Where also will be found remarks as to judging of distance by the *flash of a gun, &c.*, and *the sound of its report* [see also p. 967], and on *the recognition of an assailant or murderer by the flash of a pistol or gun*, which we think can no longer be considered as doubtful. Of course normal sight is presupposed or correction of myopia, &c., by lenses.

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* In 1838, whilst reconnoitring in Algeria, the Duke of Orleans was greatly annoyed at the pranks played by an Arab sheik at a distance of about 650 yards. [The arches below the County Fire Office at the Quadrant, in Regent Street, are about 600 yards from the Duke of York's pillar.] He offered five francs to any soldier who would knock the Arab down. A soldier stepped out from the ranks of the Chasseurs d'Afrique (Tirailleurs de Vincennes), and instantly shot the Arab chief through the heart with his rifle.

In order to judge of distance in taking aim numerous instruments have been devised, with the names of telecometer, stadium, &c., &c. They seem to us to have but little importance in regard to medico-legal matters, except a question arose as to recognizing a man, or the possibility of aiming at or hitting him at a certain distance. Messrs. Holtzapffel (64, Charing-Cross), and most gunsmiths and opticians, keep such instruments.

The question might be raised: *How long does a rifle bullet take in travelling?* In other words, what time is spent in actually firing the shot? Hans Busk (p. 65, of "The Rifle, and How to Use it") gives the result of some experiments with shells 2½ diameters long, 24 gauge, weighing 615 grains, with a charge of 2½ drams of powder. We select the numbers of greatest interest to us as medico-legists.

Time in Seconds and thousandths of a Second.

Yards.	Seconds.	Yards.	Seconds.	Yards.	Seconds.
100	·325	600	1·975	1200	4·500
200	·650	700	2·350	1300	5·000
300	·975	800	2·750	1500	6·000
400	1·300	900	3·160	1800	7·950
500	1·625	1000	3·600	2000	9·400

With a four-grooved single rifle, No. 8 gauge, weighing 14 pounds 8 ounces, and with shells of similar shape, but weighing 3 ounces 8 drams (avoirdupois), and with a charge of 4 drams of powder, the time of flight was as follows:—

Yards.	Seconds.	Yards.	Seconds.	Yards.	Seconds.
700	2·380	1000	3·620	1800	7·900
800	2·785	1200	4·570	2000	9·120
900	3·203	1500	6·140		

"From these tables we deduce that the average rate at which a rifle-ball travels is about 7½ miles per minute, or supposing it capable of undiminished continuance, about 450 miles per hour. During the same interval the earth travels 68,000 miles, so that the velocity with which we fly through space is rather more than 150 times greater than the highest speed we can give to a rifle-ball."

When well-made, a rifle-barrel will stand a tremendous strain. One of Daw's four-guinea rifles is said by the same Author to have stood the enormous strain of *two* regulation charges, and a *space of four clear inches* between the apex of the first and the basis of the second bullet. The barrel stood the trial without any injury beyond a slight bulge, not perceptible externally, and scarcely the $\frac{1}{1000}$th of an inch at the part where the second bullet was placed! So well made are Colonel Colt's weapons that only one in nearly 3,000 burst when being proved! Many of the accidents from fire-arms (bursting of sporting weapons, &c.), arise from their not having been proved. It should be distinctly known that a gun-maker has no right (by law) to sell a fire-arm to any one unless it have been tested in London, Birmingham, or elsewhere, as required by statute. Those tested by Government and rejected are marked with something like a double R, or two R's back to back.

Machine guns, whether worked by steam or hand, are as yet almost curiosities so far as Englishmen are concerned, though the *Mitrailleuse* did some service in the Franco-German War of 1870. In general the size of the bullet is nearly like that of ordinary infantry rifles. These monsters may be silenced by artillery, but are very serviceable in such situations as the head of a bridge, or in a narrow defile, or in a breach. There are two kinds, at least; viz., the *intermittent*, in which *firing and loading* are successive, or alternate operations, as in the *Montigny Christophe Mitrailleuse*; and the *continuous*, in which firing and loading go on simultaneously, the barrels being fed in turn as they pass a certain point with cartridges, as in the *Gatling* arm. This has been preferred for the British service. In the trial at Shoeburyness, the Gatling, of ·42-inch calibre, on one occasion discharged 657 rounds in two minutes, whilst the Montigny, of ·577-inch calibre, delivered 370 rounds in the same time as its maximum.

The bullets may be made to carry close, or with a little dispersion. It is said that one poor German soldier, living in 1871, had been struck by thirty-two mitrailleuse bullets! This, whilst showing a novelty in warfare, was clearly a waste of metal as far as the purposes of war are concerned. [" Popular Encyclopædia," article " Mitrailleuse "].

II. As regards the construction of cannon, or field, fort, and fleet guns, used on shore or at sea, we need not say much. The details are usually less complicated than those of rifles, though like these they are divided into *breech* and *muzzle* loaders, yet the lock is dispensed with in all except a few curious weapons not actually used in warfare. The *cannon*, or gun, is usually mounted on a *carriage*; its bullets, or rather balls, are usually of iron, and are either solid or hollow (shells). The interior of the gun-tube is called its *bore*, as in the rifle. It may be smooth or grooved, and if the latter, is usually rifled—that is, the groves run in a spiral direction, or the bore itself is twisted, as in the Lancaster gun. The solid metal behind is the *breech*, terminating in the *button*. The *trunnions* are the projections on each side, about the middle of the cannon, forming the pivot on which it turns, on being elevated or depressed. The *vent*, or *touch-hole*, is the part through which the fire is introduced into the bore to discharge the gun. A small tube (*friction* tube) is made of copper and filled with powder, and this is introduced into the vent to fire it in land service. At sea, a sort of tow-match is often used. But percussion fuses are now often substituted in breech-loaders. Cannon are generally made of iron, and cast. But of late wrought-iron with steel linings, and brass, and gun-metal (ten parts of copper to one of tin) cannon have been much used. Some of the most ancient are a kind of brass. As regards their cost, cast-iron guns now average about £21 a ton of their weight; Armstrong guns, built up, and lined with steel, £100 a ton; Krupp's steel guns, £170 a ton; whilst the gun-metal ones mentioned above, cost from £187 to £200 per ton. The name of cannon was probably derived from *canna*, a reed. Strange as it may seem, cannon have been made of wood [wood lined with metal was pretty common in the early days of artillery], lead, and even ice [St. Petersburg, 1740; balls of many pounds weight were fired without injuring these ice-cannons]. Large guns are named either from the weight of the shot, as 6-pounders, 12-pounders, &c., &c., or from their own weight, as a 25-ton gun, a 35-ton gun, 700 pounder gun, &c., or sportively, as the "Woolwich Infant," "Queen Bess' Pocket-Pistol," "Mons Meg," &c. One at Bois le Duc is named the "Devil!" The following names are obsolete: cannon royal, or carthouns [48-pound shot]; bastard cannon, or $\frac{3}{4}$ and $\frac{1}{2}$ carthouns [36 and 24-pounders]; whole culverins [18-pounders]; demi-culverins [9-pounders]; falcon [6-pounders]; sakers [5, or 6, or 8-pounders]; basilisk [48-pounders]; serpentine [4-pounders]; aspic, 2; dragon, 6; siren, 60; falconets, 3, 2, and 1-pounders; moyens, a ball of 10 or 12 ounces; rabinets, a 16 ounce or 1-pounder ball.

Mortars are very short guns, or cannon, made with a very wide bore, and now always fired at a great elevation [by theory 45° in vacuo, in practice about 43°.]* They are chiefly used for throwing *shell*, *i.e.*, hollow shots, constructed so as to explode. They are also used to throw rockets, and sometimes for solid shot. Originally it would appear they were intended to throw red-hot shot, and large balls of stone. Hence in Germany the calibre is estimated by the weight of the *stone* the mortar will throw. In Denmark and Russia it is named after the weight of the iron ball which fits it. In France and Great Britain it is usual to speak of a mortar by the diameter of the *bore*. Like other large guns, they may be rifled or bored eccentrically. Sometimes bags of grape-shot or chain-shot are thrown from them, and, from the facility of loading, all manner of things can be fired in this way. Owing to the great elevation of the fire, the shells are said to "search behind cover," and their moral effect is probably greater than their destructive powers. Owing, however, to the shells being furnished with time fuses, and the fact that great accuracy of aim is not yet attained in this system of firing, it so happens that old soldiers are but little terrified by shells when there is plenty of room or sufficiency of water at hand. But if they fall amongst masses of men, in hospitals and barracks, or amongst powder or inflammable materials, they often work fearful havoc—setting buildings on fire, exploding powder, splintering granite and other stone defences, &c. At Sedan the French dead were found torn into masses of "flesh and rags" by Prussian shell! It is generally thought that the Germans invented mortars, and that they were used at the siege of Naples, in 1435, by Charles VIIIth. It is more certain that shells were thrown out of mortars at the Siege of Wachtendonk, in 1588, by the Count of Mansfeld.

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* A "degree," in this sense, equals the 360th part of a circle (400th part on the old French system); hence, 90° are a right angle ∟, or corner of a square, and half of this is equal to 45°. A degree has 60 minutes (′), and this minute 60 seconds (″).

The name is no doubt from the Italian mortaio [a mortar used with a pestle], or the Latin word *mortarium*, with the same meaning. The *bombs*, or shells thrown from mortars, are filled with a variety of compositions. The following is very commonly used :—A bomb of seventy-four pounds contains from five to eight pounds of gunpowder, and one pound of *composition*, consisting of equal parts of sulphur and nitre with some mealed powder. In 10-pound bombs a pound of gunpowder and two or three ounces of the composition are used. But picrate of potash and fulminating powder, and even Greek-fire, have been used (Parisian conspirators against Napoleon III., and Siege of Charlestown in the American Civil War). *Howitzers* are chambered pieces of ordnance or short length, intermediate between cannon and mortars. They may be, and are now, grooved and rifled. They are used to fire shells (which can, however, be fired by ordinary guns); and, like mortars, their fire is almost vertical. The château of Hougoumont at Waterloo was burned by the shells of Jerome Buonaparte. And in the Siege of Strasburg, in 1870, the Prussian Engineers, by calculation and testing, succeeded in destroying the hidden sluice-gates in the ditch of Strasburg; this was justly deemed a very skilful achievement. Twelve-pounders and twenty-four-pounders are common sizes. A *grenade*, sometimes confused with a bomb, is of smaller size, being usually about 2½ inches in diameter. It is made of iron, and hollow, so as to contain explosives. They may be, and have been, thrown from mortars, though the practice is considered very dangerous. They have, successively, been made of glass, paper, bronze, and iron. Vauban esteemed them highly. They used to be thrown by hand—hand-grenades giving the name to our *Grenadiers*. They are little used now.

Perhaps the greatest achievement of gunnery in modern times was achieved by the 35-ton gun, of twelve inches calibre, termed the "Woolwich Infant," with a charge of 110 pounds of pebble powder, and a 700 pound "Palliser chilled shell." This shell drove its head through 18½ inches of solid iron, and 12 inches of teak wood! This was sufficient to penetrate the thickest armour of such ships as the British *Devastation* or Russian *Peter the Great* at short ranges! Of course a whole line of men would be knocked down at once by its mere impact, and if it burst it might destroy a whole regiment! *

The following rules (founded on the specific gravities of lead and iron, which equal 11·3 and 7·7 respectively), have been given for estimating the weight of *spherical* balls made of these metals :—

1. To find the weight of a *leaden* ball from its diameter.

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* Since writing the above this has been greatly exceeded by the new Woolwich Infant, or 80-ton gun. The *target* had a total thickness of 47 inches, consisting of 4 armour-plates of iron of the finest quality, each 8 inches thick (or 32 inches of solid iron), and 15 inches of teak timber (5 inches between each plate). This was further strengthened by props and piles behind and below.

The *charge* was 370 pounds of pebble powder, the *projectile* a *Palliser* shell, fitted with copper gas check, weighted with 1,700 pounds of sand, and plugged. It made an aperture 17½ inches by 16¼; the total length of the projectile was 42 inches, and this would give a penetration of 47 inches on the total thickness of the target, if the shot had not been flattened and bulged outwards. As it was, the rear-plate was bulged outwards to the extent of 7 inches. In a compressed form the projectile was flung back 40 yards towards the gun; one fragment flew 300 yards.

The velocity as it reached the target, was 1,496 feet per second, equal to an energy of 26,400 foot tons, or 527 foot tons per inch of the shot's circumference. The recoil was nearly 46 feet up an incline.

Multiply the *cube* of its diameter by 2, and divide by 9, and the quotient will give the weight in pounds.

E. g. The weight of a leaden ball of five inches diameter is required. Then $5 \times 5 \times 5 = 125 =$ cube of diameter. Then $125 \times 2 \div 9 = 250 \div 9 = 27\frac{7}{9}$ lbs.

2. To find the weight of an iron-ball from its diameter.

Cube the diameter, multiply by 9, and divide by 64; the result is the required weight in pounds.

Required the weight of an iron ball of 5 inches diameter?

$$5 \times 5 \times 5 = 125 \text{ ; and } 125 \times 9 \div 64 = 17\tfrac{37}{64}\text{lbs.}$$

These rules do not apply to *elongated* shot (cylindro-conoidal, &c.), which are now chiefly used. For example, a $4\frac{1}{2}$-pounder gun will fire a 9-pounder shot on the new principles. The weight depends, of course, on how many diameters the balls are in length. Such questions, however, seldom enter into medical jurisprudence.

We shall, therefore, before entering on the consideration of the peculiarities of gunshot and other wounds from fire-arms, proceed to discuss briefly—

The General Theory of Projectiles, and the Practical Laws of Gunnery.

We must premise that a bullet in motion is subject to the ordinary laws of gravity, to the resistance of the air, and to what are often called the *Newtonian* laws of motion, from their being found in Book I. of the "Principia." [They were, however, contained in *Des Cartes*' "Principia Philosophiæ," part ii., pp. 38, 39, and 40, published before Newton's "Principia."] Briefly stated, these laws are as follows:—

LAW I. *Every body perseveres in its state of rest or uniform motion [in a straight line], unless it is compelled to change that state by forces impressed thereon.* Hence a ball from a cannon, or a bullet from a gun, would not deviate from its first direction, or tend to the earth, if the action of gravity and the resistance of the air did not alter and retard its motion. The same may be said of an arrow, of a stone thrown from a sling, of the boomerang used in Australia, of a spear thrown by hand, &c.

This first law is sometimes called the *law of inertia*, and expresses the entire indifference of matter to motion or rest. The idea, however, that all matter has a tendency to rest appears to be a common error. For in vacuo [and our vacuums are never perfect] a pendulum, only resisted by the stiffness of the thread which suspends it, will swing all day; and a top, retarded only by the friction of its point, will spin for hours. How long the planetary motions have continued we can scarcely hope to know, though Sir William Thompson believes that for our solar system the matter admits of being determined with at least approximate accuracy, and that it is far from being the eternity of ages which some materialists assert.

When a body is moving uniformly—that is, when it passes over equal spaces in equal times—we may define its *velocity* or speed, as the space passed over in one second (of ordinary time). The law may be written in the form of $V = \frac{s}{t}$, when s is the space or distance moved over uniformly with the velocity V in the time t. The law is true, no matter how short the time may be; thus, if a body moves uniformly through the space of 0·24 foot in 0·001 second, its velocity is $0{\cdot}24 \div 0{\cdot}001$, or 240 feet per second. Now the initial velocity of a shot varies from about 1500 to 2000 feet per second. If unresisted by the air, and by gravity, the shot mentioned at p. 1104, instead of taking nearly two seconds to do 600 yards would do the distance in about one quarter the time, or one half second.

Law II. *The alteration of motion, or the motion generated or destroyed in any body, is proportional to the force applied; and is made in the direction of that straight line in which the force acts.* Thus, if any motion be generated by a given force, a double motion will be produced by a double force, a triple motion by a triple force, &c.; and, considering motion as an effect, it will always be found that a body receives its motion in the same direction with the cause that acts upon it. If the causes of motion be various and in different directions, the body acted upon must take an oblique or compound direction.* Hence *a curvilinear motion* cannot be *produced by a simple cause, but must arise from different causes acting at the same instant upon the body.*

But Newton's Third Law of Motion, explains what is called the *recoil* of fire-arms, or the *kick* of a common gun. It is as follows:—

Law III. *To every action there is always opposed an equal reaction, or the mutual actions of two bodies upon each other, are always equal and directed to contrary points.* "If we endeavour to raise a weight by means of a lever, we shall find the lever press the hands with the same force which we exert upon it to raise the weight. Or if we press one scale of a balance in order to raise a weight in the other scale or pan, the pressure against the finger will be equal to that force with which the other scale endeavours to descend." When a cannon is fired, the impelling force of the powder acts equally on the breach of the cannon, and on the ball; so that if the cannon, with its carriage, and the ball, were of equal weight, the carriage would recoil with the same velocity as that with which the ball issues out of the cannon. But the heavier any body is the less will its velocity be, provided the force which communicates the motion continues the same. Therefore, so many times as the cannon and carriage are heavier than the ball, just so many times will the velocity of the cannon be less than that of the ball. Advantage is taken of this, in Moncrieff's and some other gun-carriages, the gun being brought nearly back to the place of firing after discharge by the recoil!

We now come to the Laws of Projectiles which are applicable to shot and shell of all sizes, fired from guns of all kinds [from pistols to cannons], and even to rockets and fireworks. Some of them are also applicable to stones, darts, arrows, and the like. "When a body is thrown vertically upwards or downwards, its motion continues to be rectilinear [first law of motion]. If a stone be thrown vertically up, or a bullet be fired in the same direction, it goes on till its initial force is counterbalanced by the resistance of the air, and the attraction of gravity, in other words, of the earth's mass. If the stone or bullet be thrown horizontally, the body will move in a curved path, because (leaving out of account the resistance of the air) it retains unchanged its horizontal velocity, but it falls faster and faster towards the ground. *When investigated by dynamics* the *curved path is found to be a parabola.*[*] A body projected obliquely [*e.g.*, a shot fired from a gun with a certain elevation], has actually a certain horizontal velocity and a certain vertical velocity. Now it retains its horizontal velocity unchanged, but its vertical velocity is altered by the force of gravity, and we again find the curved path which it follows to be a *parabola.*[†] *With a given velocity the greatest range is obtained by projecting* at an angle of 45° with the vertical [the cross-bar of this N is nearly 45°]. *See* remarks under *Mortar*, p. 1106. Very accurate aim is, however, next to impossible. We have supposed the air to offer no resistance to the motion of the projectile, but in gunnery this resistance is of very great importance, because of the exceeding great velocity of the bullet or ball; and, indeed, in practice, the above theory is not of very great use. Yet it is the best we have, and the path of the bullet or its *trajectory* is always within the parabola of the theoretical projectile, and hence its range is much less. For example, when the velocity is 2,000 feet per second, the resistance of the air is about 100 times the weight of the ball, and the greatest range which, according to theory, should be 23 miles is less than 1 mile ["Popular Encyclopædia"]. Burat says:—"The flight of projectiles offers us an example of the transformation of work into vis viva, and of vis viva into work again. Whilst the bullet, weighing P, is in the gun, it is subject to the pressure of the gas from the gunpowder; if we call the mean pressure of this gas on a great circle of the bullet F, and the length of the barrel l, the work of the powder will be F × l, and the initial velocity V will be proportional to these quantities thus:—

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* Many of you are familiar with what is called the *parallelogram of forces*, [Newth's "Elements of Mechanics," &c., chap. ii., p. 5]. "If two concurrent forces [AO and BO], acting upon a point are represented in magnitude and direction by the two sides of a parallelogram [O A D B.], then will their resultant also be represented in magnitude and direction by the diagonal drawn through the given point [O]." The "*triangle of forces*," and the "*polygon of forces*," are founded on the same law of motion [Newton's IInd, given above in the text]. This law greatly simplifies the study of Kinetics, for it shows us how to reduce a number of forces to one single one, which is called the *resultant*. We shall presently see that the *trajectory* of a bullet is the resultant of the forces of gunpowder, gravity, and the resistance of the air.

$$2\,F\,l = \frac{P}{g} \times V^2.$$

When the bullet penetrates masonry, this vis viva—$\frac{P}{g}V^2$, will be transformed into work again, and if we call the mean resistance R, and the actual penetration e, we shall have:—

$$\frac{P}{g}V^2 = 2\,R\,e,$$

if we disregard the vibration communicated to contiguous parts, and to the air around [*loc. cit.*, p. 170].

The MOMENTUM, or energy, of a body falling through the atmosphere is the mass or weight multiplied by the square root of the height it has fallen through, multiplied by 8·021. Thus, a one ounce ball, falling from a height of 400 feet, would strike the earth with a momentum of—

$$\overset{\text{oz.}}{1} \times (\overset{\text{feet.}}{20} \times 8{\cdot}021) = \overset{\text{oz.}}{160{\cdot}42} = \overset{\text{pounds.}}{10{\cdot}026},$$

or, in its fall of 400 feet, the ounce has become equal to ten pounds.[‡]

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[*] A parabola is that section of a right cone which is made parallel to a slant side. Water, from a pump or water-cart, or escaping from the side of a cask, assumes this curve.

[†] The experimental proofs are very clearly given in Mons. E. Burat's "Précis de Mécanique." Paris, 1869.

[‡] Gravity, or the attraction of the earth, or larger mass, for the bullet (or stone

In the case of projectiles, fired either horizontally or obliquely, the momentum equals the mass or weight, multiplied by the velocity.

Whewell gives the following formula for the range, altitude, and time of flight of bodies projected along planes inclined to the horizon [in a vacuum].

1. Let r = range; A = greatest altitude; t = time of flight; v = velocity of projection; h = height due to this velocity; α = angle of projection above the horizontal plane; ι, equal elevation of the plane above the horizon; $g = 32\frac{1}{6}$ feet (or gravity); then we have the following equations:—

$$r = \frac{2\,v^2}{g} \cdot \frac{\sin.\,(\alpha-\iota)\cos.\,\alpha}{\cos.^2\,\iota} = 4\,h\,\frac{\sin.\,(\alpha-\iota)\cos.\,\alpha}{\cos.^2\,\iota}.$$

$$\mathrm{A} = \frac{v^2}{2\,g} \cdot \frac{\sin.^2\,(\alpha-\iota)}{\cos.^2\,\iota} = h\,\frac{\sin.^2\,(\alpha-\iota)}{\cos.^2\,\iota}.$$

$$t = \frac{2\,v}{g} \cdot \frac{\sin.\,(\alpha-\iota)}{\cos.\,\iota} = \frac{\sqrt{2\,h}}{g} \cdot \frac{2\sin.\,(\alpha-\iota)}{\cos.\,\iota}.$$

$$\text{Greatest range} = \frac{2\,h}{1 \times \sin.\,\iota}.$$

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or ball) or the smaller mass, has been so frequently mentioned above, that its application to the case of *falling bodies* must be briefly mentioned here. (1) When a body falls (from rest) it acquires a velocity of about 32·2 feet per second, varying slightly with the locality. At the end of five seconds, therefore, the body would be found moving at the rate of 5 × 32·2, that is, 161 feet per second. Hence, the formula, $v = g\,t$, the velocity equals gravity, or 32·2 feet multiplied by the time in seconds. (2) The space fallen through in the first second is half of 32·2, or 16·1 feet, and the space fallen through in any given time is found by multiplying the square of the number of seconds by 16·1. Thus, in three seconds a body falls 9 × 16·1 feet, or 144·9 feet. The formula here is, $h = \frac{1}{2} g\,t^2$, h equalling height in feet, and t time in seconds. If we take the number 16 as a very close approximation, the number of seconds that a body falls through in a given time is equal to the square of the number of quarter seconds. Thus, in the case just given, three seconds equal twelve quarter seconds, and the square of 12, or 144 feet, is the number of feet fallen through. Besides its application to projectiles, the rule is of use in the following cases. Suppose we wish to ascertain the depth of a well or mine, or to know what length of rope is required for it, or to reach to the bottom of a crevasse. With seconds-watch in hand, note the time a small pebble takes to strike the surface of water, or the bottom of the crevasse, &c. Let us suppose this to be five seconds. Then $h = \frac{1}{2} g \times 5 \times 5 = 16 \times 25 = 400$ feet, or, more accurately, $16{\cdot}1 \times 25 = 402{\cdot}5$ feet. (3) $V^2 = 2\,h \times 32{\cdot}2$. Thus, if a body falls nine feet, we get $v^2 = 18 \times 32{\cdot}2 = v^2 = 579{\cdot}6$ feet. Therefore $v = \sqrt{579{\cdot}6}$, or 24·6 feet nearly. So that a body in falling nine feet acquires a velocity of 24 feet per second. (4) When a body is projected vertically upwards with a given velocity, it continues to rise during a number of seconds, found by dividing the number that expresses the velocity of projection by 32·2; and it rises to a height found by dividing the square of that number by 2 × 32·2, or 64·4 This may be expressed thus:—

$$t = \frac{v}{32{\cdot}2} \text{ when } t \text{ equals time in seconds, and } h = \frac{v^2}{2\,g} \text{ when } h \text{ equals height.}$$

Or, as 32·2 equals gravity (see above), these are often written thus:—

$$t = \frac{v}{g}, \text{ and } h = \frac{v^2}{2\,g}.$$

Suppose, therefore, a bullet is fired vertically upwards with a force of 2000 feet per second, then (disregarding the resistance of the air, and fractions)—

$$t = \frac{2000}{32}, \text{ or 125 seconds = 2 minutes, 5 seconds,}$$

and it will rise to a height of 62,500 feet, or 11¾ miles. This is *in vacuo.* In practice it is only about 2,920 feet, or a little more than half a mile.

2. When $i = o$; r will be the horizontal range; and the above equations will become :—

$$r = \frac{v^2}{g}. \text{ sin. } 2\,a = 2\,h \text{ sin. } 2\,a$$

$$A = \frac{v^2}{2\,g}. \text{ sin. }^2 a = h \text{ sin. }^2 a$$

$$t = \frac{2\,v}{g}. \text{ sin. } a = \frac{\sqrt{2\,h}}{g}. \; 2 \text{ sin. } a.$$

Greatest range $= 2\,h$.

3. The curve described by a projectile is a parabola, the principal parameter of which $= 4\,h \text{ cos.}^2\, a$, and the velocity at any point is that acquired by falling from the directrix. For other formulæ, see Carr's "Synopsis," p. 214. In practical gunnery, as we have said before, the problems are complicated by the resistance of the air (modified by the shape of the projectile), as well as by the force of gravity, and the angle of elevation. Hutton gives the following formulæ :—

1. To find the initial velocity of a shot.

Let P = weight of powder; B, of the ball; v, the initial velocity; then—

$$v = 2000 = \sqrt{\frac{P}{B}}.$$

Cor. 1. The initial velocity of a shot varies from 1,660 to 2,000 feet per second.

Cor. 2. $B\ v^2 = (2{,}000).^2\ P$, *i. e.* the effect of a shot is nearly as the quantity of gunpowder [there are, of course, practical limits to this, in the strength of the barrel, &c. &c.]

2. If w = weight of any ball; d, its diameter.

$$w = \cdot 5236\ d^3 \text{ in pounds.}$$

This refers to spherical bullets only.

3. To find the resistance of the air to any ball or projectile.

Let d = diameter of ball; v, its velocity; r = resistance in avoirdupois pounds; then :—

$$r = \frac{d^2}{1000}\left(\frac{2\,v^2}{3000} - v\right).$$

Example.—Resistance to an iron ball, whose diameter is 2·78 inches (or weight 3 pounds), when thrown with a velocity of 1,800 feet per second = 176 pounds, more than 58 times its own weight.* This is modified by the shape of the projectile.

4. Supposing the air to resist according to the laws just assigned, required the height to which a ball will ascend perpendicularly.

Let d equal diameter of ball; c, the velocity of projection; h, height ascended, then :—

$$h = 760\ d \times \text{log.}\left(\frac{c^2 - 150\,c}{21090\,d} + 1\right).$$

Example.—A ball of 1·05 pounds, discharged with a velocity of 2,000 feet, will ascend to the height of 2,920 feet. In vacuo it would have ascended to the height of $11\frac{3}{4}$ miles.

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* Many authorities state that the resistance is a hundred times the weight of the ball.

5. If a body descending in the atmosphere has acquired such a velocity, that the resistance is equal to its weight, the accelerating and retarding forces being equal, its motion will become uniform; to find this terminal velocity—

$$\frac{2v^2}{3000} - v = 523{\cdot}6\,d.$$

A quadratic equation, from whence v may be found.

Example.—For an iron ball of 1 pound the terminal velocity = 244 feet; for one of 42 pounds, it is 456.

6. The rule as to gunpowder has been given at p. 1102. It begins:—"The best charge of powder is about $\frac{1}{5}$th or $\frac{1}{6}$th of the weight of the ball, &c." [See Young's "Natural Philosophy."

As regards *elevation* it is now generally agreed that although angles of 45° or thereabouts are capable of the greatest velocity with large shot or shell, yet that with smaller shells, angles of 30° or thereabouts are capable of greatest velocity. Hans Busk gives the following practical rules:—

1. *The time of flight of a ball is nearly as the range*, the gun and elevation being the same. [To judge of *distance* by the time between the flash and the report, calculate as for lightning and thunder, pp. 639, and 967, or "multiplying the seconds between flash and report by 1,100, which gives the distance in feet, or one mile in $4\frac{4}{5}$th *seconds*."]

2. The *velocities decrease* as the *distance increases.*

3. *Very slight advantage is gained by increasing the charge* of powder more than is necessary to gain the object.

4. *Increasing the length of barrel (or gun) gives little advantage.*

5. *The resistance of the air against balls of different diameters, with equal velocities, is almost proportionate to the squares of their diameters.*

6. *Considerable increase of velocity is gained by diminishing windage.* In other words, the tighter a bullet fits, the faster it flies (*cœteris paribus*).

7. The velocity increases with the charge up to a certain point, peculiar to each gun, but so does the recoil. [The more powder, the more kick in the gun!]

8. The depths to which balls of the same size penetrate wood, with different velocities, are nearly as the squares of the velocities. A large ball will not only make a larger hole, but will also penetrate further than a small one with the same velocity [the momentum being greater]; in other words, balls of different sizes will penetrate to depths proportionate to their diameters.

By experiments at a mean range it has been ascertained that in common earth dug up, and well-rammed, a musket-ball buries itself 17 *inches;* a 6-pound shot, from $3\frac{1}{2}$ to $4\frac{1}{2}$ *feet;* a 9-pound shot, from $6\frac{1}{2}$ to 7 *feet;* a 12-pound shot from $8\frac{1}{2}$ to 10 *feet;* an 18 or 24-pound shot from $11\frac{1}{2}$ to 13 *feet.* See the "Artillerist's Manual."

From the sources already quoted, we also take the following, as to fire of muskets or rifles.

"The French have adopted the following rules for firing, for ranges varying from 100 to 215 yards:—

"*To hit the middle of the body.*—At 100 yards: aim at the breast; from 100 to 150 yards, at the shoulders; from 150 to 190 yards, at the head; from 190 to 215 yards, aim at the top of the cap. We deduce from these rules that a musket-ball falls 6 inches in the first 100 yards, and 6 inches for each of the succeeding distances laid down, until at a range of 215 yards the fall becomes 24 inches. This occurs, it is to be remembered, with the grooved weapons, or rifles. These grooves, impressing a rotary or spinning motion on the ball, keep it far steadier than would otherwise be possible. In fowling pieces, and weapons not rifled, the range is far wider."

We may be asked, why we have been thus diffuse, and why we have dwelt on the parabolic theory, which confessedly refers to balls fired in vacuo? Our answer is this : We have shown you the difficulties of the subject, to guard you against dogmatism. In any disputed point let experiments be made, or the prisoner have *the benefit of the doubt,* if the best authorities differ.

We have dwelt on the parabolic theory, because the actual trajectory or flight of the bullet is always within or below this curved line. And because, when the opposing forces are allowed for, and the necessary corrections made, this seems the only true theory of gunnery.

To repeat as to the flight of the ball, or its trajectory. The ball would go straight if unopposed—being opposed by gravity, it tends to fall to the ground—hence its line of flight is parabolic. But the resistance of the air to the bullet modifies and lessens its original velocity. Hence the curve is still further modified. A certain elevation is given to the line of fire, or of the bullet (by means of the *sights* in a rifle, and by tilting large guns), and this still further modifies the curve. The flight or trajectory of a bullet in practice is a curved line, which first ascends, and then descends, the best effect occurring at the point where the line of sight cuts the curved line of fire. An elevation of about 25° with globular bullets gives the best range. But at 4° 30′ the range is about 640 yards with the Minié rifle. There are two points in the line of fire in which the trajectory or true course cuts the former. These are both called points-blank. The first is very close to the muzzle. To ensure striking an object within the point-blank, we must aim *under* it; but if the object is beyond the point-blank, we must aim above it. The effects of a high *wind* is one of the causes of uncertainty of aim.

To sum up, the gun, or other firearm, may be large or small; smooth-bored, or rifled; a breech-loader, or loaded at the muzzle. There is a ramrod attached to both breech and muzzle loaders; in the latter, for ramming; in the former, to extract cartridges, clean the bore, &c. It may, or may not, have a bayonet, or some sort of sword attached. Its weight may vary from a few ounces to many tons. As regards the charge, there is generally gunpowder, but sometimes gun-cotton, or prepared sawdust, or some other explosive material is used instead. The bullet or shot is usually of lead, if of moderate size or weight; of iron, if of large size: it may be solid, or hollow and filled with explosive substances. The powder and shot may be contained in a cartridge, or kept apart by means of wadding. In some of Colt's revolvers there is no wadding and no cartridge. The cartridge or case may be of paper, or pasteboard. In some weapons it is entirely consumed. Sometimes the cartridge is of metal. In firing it may, or may not, be got rid of. The cartridge may contain its own means of ignition or explosion, only requiring a blow from the mechanism of the gun. Or it may be fired by a percussion-cup, or by a needle in the gun itself. Large guns and mortars are sometimes fired by matches or time-fuses even now. Lastly, as in rockets, the tube or gun may sometimes be dispensed with altogether, and the missile may direct its own course. A man may be shot at by one of these weapons, and wounded by one or more discharges; or he may chance to receive the charge from a number of barrels of such a weapon as the "Gatling," or the Mitrailleuse used by the French. We shall now proceed to give the

General Character of Gun-shot Wounds.

"They are always more or less of the *contused and lacerated character*, followed by sloughing and suppuration, and never healing but by the second intention. The sloughing is in part an immediate result; partly secondary, from excess of action over power, as in other contusions. Hæmorrhage is seldom great, unless a large artery be directly implicated. Yet gun-shot injury being generally extensive, and arteries of some considerable size consequently certain to be more or less wounded, danger is not slight from direct loss of blood. Often, from the form of wound, little blood may show externally, while a fatal hæmorrhage is advancing in the interior. The extent of injury is very various. A ball may merely graze the part, scarcely inflicting a flesh bruise; or it may impinge, so as to fracture bone, without division of the integument. It may enter a part and lodge, or it may effect a complete perforation. A limb may be carried away, as if by a rude amputation; or it may be pounded almost to a jelly, yet remaining in contact with the living trunk. *The cannon-ball seldom lodges.* Round-shot, of large size, have been found imbedded in the glutei muscles, or even in less fleshy parts; but the occurrence is rare. *Lodgment of the musket* (or rifle) *bullet, on the contrary, is extremely common. The aperture made by the bullet's entrance is small, and with the edges inverted.* Often it appears of much less dimensions than the foreign body which has passed through it; and *sometimes it may even simulate the incised character.* In such cases the ball has come from some distance, and has struck with considerable force and velocity; the aperture, consequently, is made with comparatively little bruising or tearing, and the resilient textures close upon its track.

"*The aperture of exit,* on the contrary, *has its margins ragged and everted;* and is *invariably of larger dimensions than that which marks the entrance.** *When the* injury is inflicted (*i. e. the shot fired*) *at a short distance*, the aperture of entrance is comparatively large; has no smoothness in its edges, and is obviously of a lacerated character: then, too, *portions of the wadding* are usually impacted in some part of the tract, and the *surface may be marked by the grains of powder.* The pain of a flesh-wound is often slight: the patient, if actively engaged, may hardly be aware that he has suffered injury. There are not a few instances in which a man, mortally wounded, has gone on fighting, and then dropped down dead suddenly. If, however, a bone be broken, or a large nerve torn, pain is usually severe, and demands instant attention. The shock, too, varies. As in other injuries, it may be either mental or corporeal. It is proportioned to the extent of injury, and the importance of the part affected. If a limb has been carried away by a round-shot, or if an internal organ, as the lung, stomach, liver, &c., has been implicated in the course of a bullet, the patient is found in a state more or less approaching to syncope, and struck with an alarm and apprehension over which he has no control; whereas, by a simple fracture, or flesh-wound, the same patient would be scarcely disturbed from his ordinary composure. Sometimes, it is true, a certain amount of corporeal and actual shock does attend even on slight injury. But in this case it is transient, either quickly passing away spontaneously, or yielding readily to ordinary restoratives. When, however, in a case of apparently slight wound, we find much depression of system, which refuses to yield, we may be tolerably certain that what before seemed trivial, is, in truth, severe, and that some internal organ has been seriously implicated. And yet it is strange how the intense excitement of hot action may prevent, or rather modify the shock to a great extent, but only for a while. 'A foot-soldier, at Waterloo, pierced by a musket-bullet in the hip, begged water from a trooper, who chanced to possess a canteen of beer. The wounded man drank, returned his heartiest thanks, mentioned that his regiment was nearly exterminated, and having proceeded a dozen yards on his way to the rear, fell to the earth, and with one convulsive movement of his limbs, ended his career. Yet his voice gave scarcely the smallest sign of weakness.' And again, when shock does exist in full force, it is remarkable how clear and unshaken the mind oftentimes remains. At Corunna, an old officer, who was shot in the head, arrived, pale and faint, at the temporary hospital, and begged the surgeon to look at his wound, which was pronounced mortal. 'Indeed, I feared so!' he responded, with impeded utterance. He laid his sword upon a stone at his side, as gently as if its steel had been turned to glass, and almost immediately sunk dead upon the turf.

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* Some years ago Mr. W. F. Teevan showed these characters in a striking way, by firing bullets through the skull from *within*, when contrary to the usual rule of punctured wounds in the cranium, the *outer* table was most splintered. "Brit. and Foreign Med. and Chir. Review" for 1865. This would be the case in a shot fired through the mouth, and perforating the skull.

"At one time it was supposed that a shock, sufficient to cause death, might be sustained from mere concussion, produced by a large shot passing by, with very great rapidity and closeness, yet without actually touching the body; and that laceration of muscles and arteries, with fracture of bones, might be produced in a similar way. But it is now well understood, that these are not the effects of mere *wind-contusions*, as they were termed, *but are produced by spent-balls*, which have really struck, yet with so little quickness or force, as to merely bruise without inflicting an open wound.* An internal cavity, as of the cranium, may sustain even a fatal concussion by the contact of a spent shot, without any signs of an outward bruise, but usually the signs of contusion are both apparent and extensive.

"A cannon-ball, when first projected, passes in a straight course, but soon assumes a curvilinear, paraboloid direction; and at the same time it rotates on its own axis (particularly when from rifled or grooved weapons), this rotation increasing with the increased distance, and the diminished velocity. Sweeping or penetrating wounds are likely to follow obstruction to the first part of its course; while in its last stage it may merely roll round, or over the part, as a wheel passes over a limb. Attention to this circumstance tends to explain the occurrence of such latent injuries, as well as to account for the extraordinarily circuitous routes sometimes taken by musket bullets which perforate. The course of bullets is at all times uncertain. A very slight obstacle suffices to cause diversion from the rectilinear direction, as evinced by the rebounding of round-shot from water. 'A button, a watch, a book, or a handkerchief, has been the means of preserving life' from the musket bullet. And a succession of such obstacles [including bones, aponeuroses of muscles, &c.] may occasion a most devious track. *The aperture of exit may be found very close to that of entrance; and yet the bullet may have nearly completed the circuit of the body.* Or a ball may strike the forehead, and emerge at a point directly opposite, in the occiput; as if it had perforated the cranium in a straight line, while, in truth, it has never been deeper than the integuments [in other words, it has skirted round the skull, and not entered it. In the same way a ball may go all round the ribs, under the skin, without entering the chest. The Authors have seen cases of this kind in civil practice.] In such cases the superficial rack is marked by a discoloured elevation, sometimes slightly emphysematous. In deeply penetrating wounds, the course may be equally unexpected: bone, muscle, fascia, proving the causes of diversion. A ball has entered the breast, and lodged in the scrotum; a ball may penetrate at the upper part of the breast in front, and lodge near the spine at a much lower plane. 'In one instance, which occurred in a soldier with his arm extended, in the act of endeavouring to climb up a scaling ladder, a ball, which entered about the centre of the humerus, passed along the limbs, and over the posterior part of the thorax, coursed among the abdominal muscles, dipped deep through the glutei, and presented on the fore part of the opposite thigh, about midway down.' [Hennen's "Military Surgery," p. 35.] As already stated, the nature of the wounds depends on the distance at which the shot has been fired, on the nature of the foreign body [bullet, wad, &c.], and on the force with which it has come. *At a short distance, powder will penetrate* by its grains, *as well as burn* by its explosion.* *At a greater, yet still limited, distance wadding* will penetrate, *and may inflict a ghastly lacerated wound;* a circumstance often not attended to by the vulgar. Lives have often been lost, and still oftener seriously endangered, by the reckless discharge, at close distances, of firearms supposed to be harmless, because only loaded with powder and wadding. [Even the explosion of a percussion cap may produce a painful wound.]

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* In the "Medical Times," September 8, 1855, J. Dringan, Esq., Surgeon, R.N., writes from Sebastopol, that "a shot *ricochetted* with great force over one of the parapets, carrying away a cap from a seaman's head. The man was a little stunned, but no farther mischief ensued. When his cap was picked up it contained a handful of hair, which had been shaved from the scalp by the shot. This would have been a poser for the old 'wind-contusionists.'" Quoted in Druitt's "Surgeon's Vade Mecum."

"*At a short distance, small shots, as in the common fowling-piece, penetrate in a mass, like a bullet;* at a considerable distance *the charge scatters,* and inflicts a more extensive but less deadly wound.†

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* When it thus penetrates, a bluish-black staining, like tattooing, is often left behind for many years, if not for a whole lifetime. Such marks are not uncommon in quarrymen.

† Dr. Taylor quotes Dr. Lachèse's experiments on dead bodies, which show that in order to produce with small shot a round opening, somewhat resembling that pro-

"*A bullet, when fired near*, passes tearingly into flesh ; when discharged more remotely, yet still moving with great velocity, its wound is smaller, and more incised ; when of very distant source it may bruise muscle, and break bone, without penetrating or even wounding the integument. *Obliquely* striking bullets produce valvular wounds. *Slugs* and *irregular portions of iron* * necessarily make more serious and extensive wounds than those inflicted by bullets. The latter impinging on bone, are apt to be flattened or otherwise altered in shape ; and when so altered, they may either pass onwards into flesh, or remain embedded in bone. *On a sharp ridge of bone, a bullet may be bisected ; and each half passing onwards, may perforate, giving rise to two apertures of exit.* Leaden pellets and bullets unaltered from their smooth rounded form, may lodge in a fleshy part without creating much disturbance. The wound closes in the ordinary way, and perhaps about the ordinary time ; the foreign body becomes surrounded by an adventitious cyst of a quasi-serous character ; and may there remain for years undisturbed, or moving occasionally from place to place ; causing but little uneasiness, except during atmospheric change—when pain, sense of weight, and general discomfort in the part, are apt to assume somewhat of a barometric character ! Sharp, irregular bodies, however, are seldom so tractable ; the surrounding parts will not tolerate their presence ; suppuration is profuse and continued ; inflammatory re-accessions are frequent ; nature is constantly reiterating her efforts at extrusion ; and quietude and closure are not obtained, until the offending substance has been dislodged and taken away. Sometimes inflammation ceases, the wound contracts, and the discharge diminishes ; yet a sinus remains, communicating with the foreign body, as if indicating and waiting for its passage outwards. In this case the bullet has an envelope of a membranous character, but not shut and serous-like, as in the former case ; rather mucous, and with an outlet. Clothing may either prevent the ball's entrance, or enter and lodge along with it. A portion of shirt or handkerchief, for example, may be carried before a bullet, with its continuity unbroken, and become impacted in the wound. On pulling out the invaginated portion of dress, the bullet will roll out from its interior ; or the clothing may be cut up, and driven inwards in portions ; and these are likely to lodge, whilst the ball may perforate and escape. Other foreign bodies too, or substances which come to enact the part of such, may lodge, and untowardly complicate the wound ; as portions of earth,

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duced by a bullet, the discharge should take place, point-blank, at the distance of not more than ten or twelve inches from the surface of the body. At 12–18 inches the opening made was irregular, and its borders much lacerated. At 36 inches a central opening was entirely lost, and the surface of the body was covered with scattered shot. The effect after this depended on distance, the charge, kind of gun, &c., but the shots were generally much scattered. [" Ann. d'Hygiène," 1836]. He quotes *Reg.* v. *Chapman* [Oxford Lent Assizes, 1839], *Reg.* v. *Hall* [Oxford Summer Assizes, 1846], and *Reg.* v. *Kendrew* [York Winter Assizes, 1844], as bearing on and confirming this view. On the other hand, Dr. Lowe fired a new gun, with the usual charge, at a sheet of paper placed at 60 paces distance : the result was a circular hole in the centre, through which, apparently, every shot had passed. The hole was slightly jagged at the edges, but otherwise like a bullet mark. Dr. Lowe thinks new guns, highly polished, throw the shot closely.

* In warfare, when short of ammunition, all kinds of things, nails, gravel, stones, &c., are sometimes used. We have known a murderer load a gun with tin-tacks and small nails.

stone, wood, and splinters of fractured bone.* Portions of the clothing, accoutrements, and even of the body of one soldier, may be impacted in the wound of his comrade." [Thus far we have quoted almost verbatim, except the notes, from Miller's "Principles of Surgery," p. 671—675, as it seemed difficult to better so clear and concise a description. We shall, however, make a few additions, referring the reader for further details, to Beck, Guy, and Taylor on gunshot wounds; to the articles with this title, in Cooper's "Surgical Dictionary," which gives a Bibliography, including most of the older works of importance on this subject; to the more modern article in Holmes' "System of Surgery;" and the chapters in Erichsen, Druitt, Bryant, and other writers on Surgery.]

Bones may be fractured, and the fractures may be simple, comminuted or compound. Sometimes bones are only fissured or splintered—at other times they are perforated. In other cases, the bones are *simply bruised.* But bruises of bone are often troublesome, and may be followed by necrosis, or other ill effects. Pyæmia is very likely to follow these injuries of bone. *Joints* may be opened by gunshot wounds—and foreign bodies (including bullets), may be lodged in them. Surgeons cannot always say at once if a ball or other foreign body has escaped. M. Nélaton could not at first determine the presence of the bullet in Garibaldi's ankle. If there is only one aperture, it is natural to suppose the bullet has lodged—but it may have escaped, as in the case described above, of a bullet rolling out when invaginated clothing is drawn out. Or the ball may have made a complete circuit, and come out again where it entered. This has sometimes happened in the head. When, however, there are two plain openings, and these bear the characters described above, one small with *in*verted edges, and one large with everted edges, and the two are nearly in a straight line, or in such relation to each other as to render their connection probable, by assuming a circuitous course, it is most probable that the bullet has escaped. Yet here we may be wrong, for it may have been halved, as noticed above, by impinging on bone, &c., and only one half have escaped as yet, the other half being there. *Or two apertures*, nearly in a line, *may both be apertures of entrance, made by two distinct balls,* both of which have lodged. This is not only probable in warfare, but amongst civilians whenever a revolver, or double-barrelled gun or rifle or pistol has been used. "*Again a plurality of openings does not necessarily imply a plurality of bullets*, for the same ball has been known to go in, come out, and enter and perforate again! or after perforation, it may be subdivided into two or more fragments, and each have its separate aperture of exit."

In order to detect the presence of bullets in a wounded person, many ingenious contrivances have been proposed. The ordinary probe, or the bullet-forceps, may at once detect the presence of metal, but when these fail, M. Nélaton has proposed a porcelain probe, which would be stained by the bullet—in fact, it would rub off a small bluish portion of lead. Small instruments, like gimlets and cheese-tasters, have been devised to scrape or screw out a bit of the bullet. And most ingenious of all, as it is applicable to iron or any kind of metallic ball or foreign-body, is an electric, or rather galvanic, "bullet-detector," which rings a small bell as soon as a circuit is formed by the bullet connecting the poles of the apparatus. The late Surgeon Major Wyatt published a paper on the detection of bullets in the "British Medical Journal" for 1870.*

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* In vol. ix. of the "Transactions of the Philadelphia College of Physicians." Dr. Weir Mitchell records the case of a bullet imbedding a piece of bone in the *median* nerve; the bone had begun to grow in its new situation.

Denmark [in "Med. Chir. Transactions," vol. iv., p. 48] has recorded a case of severe neuralgia, or rather tic-doloureux, from the lodgment of a small bit of bullet in the *radial* nerve. [Quoted by writer of *Art.* "Gunshot Wounds" in Cooper's "Dictionary of Surgery," p. 1097.] On referring to the original it appears that it was in a soldier of the 52nd Regiment wounded at the storming of Badajoz, April 6, 1812.

The best *treatment* of gunshot-wounds is not within the scope of a work like this. Incidentally we may, however, mention, that the *cold-water treatment* of the *Val de Grâce* Hospital of Paris in 1848, the use of *ice* by Esmarch, and Stromeyer—frequent *irrigation*, and *antiseptic treatment* appear to be most in favour with military surgeons. The *dangers of gunshot wounds* are, however, strictly within our province. We cannot always judge of these at first. They may of course prove instantly or rapidly fatal by hæmorrhage, shock, syncope, and the like. But the chief danger is when suppuration has been established. The sloughs become detached and involve the whole track—though generally most near the entrance, where there has been most *bruising*. When these sloughs separate, bones, joints, arteries, cavities, and canals, and nerves, may be exposed which previously were deemed *un*implicated. "The accidents which are likely [says Miller] to occur during the progress of cure, are many and formidable; excess of inflammation and of inflammatory fever; erysipelas; abscess after abscess, by inflammatory re-accession, probably connected with the lodgment of foreign matters; diffuse purulent infiltration; inflammatory action in veins, either in hard or soft textures, perhaps of the diffuse and suppurative kind; untoward extension or recurrence of sloughing; hæmorrhage on the separation of sloughs, or by subsequent ulceration; accession of sloughing phagedæna, [or hospital gangrene]; non-union of fracture; necrosis, caries; exhaustion by hectic; tetanus; pyæmia [and septicæmia]; paralysis; impairment of intellect; and loss of sexual and muscular and mental power, are some of these dangers. The conical bullets used in Minié rifles, and the elongated, conoido-cylindrical bullets of the Enfield, Chassepot, Needle gun, Martini-Henry, Snider, and other weapons, are far more destructive and murderous than the old spherical ones. In the Crimean, Franco-German, and other recent wars, they have been found to go through not only two, but as many as three men, perhaps lodging in the body of the third. They deviate from their course far less than the old ones. They generally perforate; in some cases drilling through bone—in others, completely smashing and comminuting it. They do not so often lodge as the old ones,† for they generally strike the small end foremost. Sometimes they channel a long groove in a bone, but so did the globular ones. But both the old spherical and the modern elongated bullets are often flattened out into the queerest of shapes, presenting very sharp angles, which rend and tear terribly. [*See* remarks under Colt's Revolvers, Mitrailleuse, &c., p. 1101.] The injuries from grape-shot are something like those from round shot, but less severe. Mr. Cole, in his "Military Surgery," London, 1852, says that "the cannon-shot for the first 500 or 600 yards, grinds to powder, and destroys everything that opposes its hissing course." If it strikes a limb, it either smashes it completely, pulpifying all the tissues it meets, or it may carry the limbs clean off. A man may be decapitated by a cannon-shot, or have both legs taken clean off. These things are, however, less matters for legal medicine than bullet wounds. In the Crimea, though severe hæmorrhage was rare from cannon balls, it sometimes happened that the femoral artery was so wounded in this way, as to cause fatal hæmorrhage; and occasionally a round shot will produce effects more like those of a bullet. This happened in the case of a private, working in the trenches before Sebastopol, shovelling up some earth, with his body bent, and his right hand holding the handle of the shovel, low down in front, between his legs. In this position he was struck by a round shot from a large gun. It shattered his arm, leaving it hanging only by the integuments; and passing between the thighs at their upper part, it tore away from each of them a large mass of the integuments and muscles, and laid bare the femoral artery on one side. It carried in front of it the penis, and scrotum, and anus, and *guided* by the curve of the buttocks, it swept away a large portion of the glutei of one side. [Druitt's "Surgeon's Vade Mecum," p. 132.] The skin is sometimes uninjured, though bones may be broken. The mischief caused by *shells*, rockets, and other explosives, has already been alluded to. The wounds from these are ragged [lacerated] in the extreme—and often frightfully contused. Druitt says that in the Crimean War, the bursting of one howitzer shell caused ten admissions into the hospital of the 18th regiment, and of those admitted, seven lost either an arm or a leg. [*See* McCormack's "Notes of an Ambulance Surgeon" for other cases, and the "Blue Books" of the Army Departments after the Crimean, Franco-German, and American Civil War.] Mr. Erichsen [*loc. cit.*, p. 112] draws attention to the fact that *powder alone*, may not only produce fatal *concussion*, when fired close to the heart, for instance, but may actually produce a round hole, like that from a bullet, as in Dupuytren's case, when a fowling-piece was discharged at a distance of only two or three feet from the abdomen. He notes also that suicides sometimes forget to put the bullet in, but frightful lacerations of the mouth, cheeks, glottis, &c., may be produced by powder and wads alone. When weapons are fired very close, the hair and skin may be singed, burnt, and *blackened* from the burning powder. This must not be confounded with the blackening due to sloughing, which is a later phenomenon. Paper-pellets and a kid glove fired from a gun have been known to kill. [The first proved fatal to a girl, the second to a man.] A single pellet of small shot has been known to destroy the eyeball, to kill by wounding the femoral artery or vein, or by lodging in the heart. Mr. Erichsen gives a case in which small shot from a pistol actually penetrated the bodies of the vertebræ. *Bad percussion-caps*, in exploding, *often splinter, and wound the right eye-ball.* This accident commonly occurs to soldiers, volunteers, and militiamen, but may be met with in little boys who play with toy-pistols, or in civilians who use guns for sporting purposes.

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* The surgeon's finger is often the best bullet-detector, when the wound admits of this being used.

† Mr. L. S. Little (Report on the War in Schleswig-Holstein, "Lond. Hosp. Reports"), and some later writers, say that conical bullets very often lodge, and that the statement in the text is inaccurate. Mr. Byron Blewitt tells us that this was due to the wretched guns with which the Danes and Prussians were furnished. In the Franco-German war the majority of the conical and elongated bullets perforated, though when nearly spent, or at long ranges, they would lodge. To avoid risks from imperfect closure of the breech-block, orders were given to many regiments to fire from the hip.

Mr. Erichsen very properly calls attention to the length of time which may elapse before the effects of a gun-shot wound are recovered from, or cause death. *General Bem required to have a bullet removed* by Liston from the external condyle of his femur *nineteen years after it first lodged there. Marshal Money* died from the effects of a gun-shot wound received forty years before.* A soldier, wounded in the storming of the Redan, in the Crimean War, died two and half years after, of exhaustion from a large lumbar abscess, caused by a bullet entering the left side of the chest, wounding the lung, traversing the diaphragm, notching the spleen, passing between the kidney and supra-renal body, and perforating the spine. It lay encapsuled on the right side of one of the vertebræ, pressing upon the right renal vessels. Its irritant effects, and those of the sequestra from the injured spine, caused the abscess which led to his death. We have said above that in the heat of action soldiers are sometimes unconscious of having been wounded. But after a severe gun-shot wound there may be a state of torpor and indifference, which is often a sign of impending death, and may be accompanied with gangrene of the injured limb. Thus Richeraud [" Nosographie Chirurg.," tom. i., p. 221, ed. 2) says : " C'est dans cet état que mourut le chevauléger, dont parle Quesnay ; l'état d'hébétude était tel, que cet individu, à qui l'on proposa l'amputation de la jambe, répondit que *ce n'était pas son affaire.*" †

To show what serious results may occur with but slight external injuries, Larrey relates the following cases :—" At the siege of Rosas two cannoniers, having nearly similar wounds, were brought from the trenches to the ambulance, which Baron Larrey had posted at the village of Palau. They had been struck by a large shot, which *towards the termination of its course* had grazed posteriorly both shoulders. In one Larrey perceived a slight ecchymosis over all the back part of the trunk, without any apparent solution of continuity. Respiration hardly went on, and the man spat up a large quantity of frothy vermilion blood. The pulse was small and intermitting, and the extremities were cold. He died an hour after the accident, as Larrey had prognosticated. The body was opened in the presence of M. Dubois, Inspector of the Military Hospitals of the Army of the Eastern Pyrenees. The skin was entire ; the muscles, aponeuroses, nerves, and vessels of the shoulders were ruptured and lacerated ; the scapulæ broken in pieces ; the spinous processes of the corresponding dorsal vertebræ, and the posterior extremities of the adjacent ribs were fractured. The spinal marrow had suffered injury ; the neighbouring part of the lungs was lacerated, and a considerable extravasation had taken place in each cavity of the chest. The second cannonier died of similar symptoms three-quarters of an hour after his arrival at the hospital. On opening the body, the same sort of mischief was discovered, as in the preceding example. [Article, " Gun-shot Wounds," in Cooper's " Dictionary of Surgery," p. 577.]

If a shot has been fired in a room, or near to a house, wall, or fence, do not forget to examine the walls or fence for bullet-marks. Both bullets and small shot are often lodged in such situations.

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* Dr. Taylor says that Marshal Maison, one of Napoleon's generals, died in the same manner.

† The light-cavalry soldier of whom Quesnay tells died in this state of torpor. So great was his indifference and apparent stupidity, that when he was told that his leg ought to be amputated, he replied *that that was no business of his !*

We will now proceed to consider the questions relating to firearms, and gun-shot wounds, which are likely to be referred to you.

These are briefly :—

1. Is, or was, the wound [or wounds] in question inflicted by firearms? In other words, is it a gun-shot wound with which we have to do?

There will usually be but little difficulty in answering this question, if you have carefully read over the preceding description. It is true that fragments of shell, and occasionally a small bullet moving rapidly, and coming from a distance, may inflict what look like incised wounds. But in general the characters of gun-shot wounds are well-marked. And even some of the doubtful ones, when probed or examined carefully, exhibit distinctive characters. If you discover fragments of powder or wadding, or the bullet, or portions of lead, or other metal, or bits of the dress carried deeply into a wound, you will be still more certain.*

2. You may be asked, "Was the shot fired close to, or at some distance from the injured person?" We must again refer you to the description given of the character of these wounds for an answer to this question. If there be singeing or burning, or clear marks of powder (grains of powder imbedded in the wound, or in its vicinity), you may be pretty certain as to the closeness of the shot. Wadding is sometimes carried further than we might suppose from *à priori* reasoning. Even paper pellets, or brown paper pressed together, with a large charge of powder, have been known to produce holes, like shot, or like a bullet, at a distance of two or three yards.

Dr. Mackintosh of Downham had a case of this kind [*Reg.* v. *Isgrite*, Norwich Autumn Assizes, 1867]. The prisoner fired at a boy with a gun loaded with brown paper pressed together. He was then at a distance of two or three yards from the boy. Dr. Mackintosh found a wound in the chest the size of a shilling. The margin of the wound was jagged, had a bluish black, or mottled appearance, and the edge of one of the ribs was laid bare. The paper pellet took a course downwards, as a result of a deflection of the projectile by the rib. A quantity of brown paper was removed from the wound, and the boy ultimately recovered. Dr. Mackintosh's first experiments failed to produce a similar result at the distance named. But with more powder he not only penetrated the boy's jacket with a similar paper pellet at three yards, but also penetrated $1\frac{1}{2}$ inches beyond. Dr. Swift, who failed at greater distances than 6 inches, probably used too little powder. [Taylor, *loc. cit.*, p. 684.]

3. You may be asked, *Was the gun or pistol loaded with ball?*

We have already seen that at close ranges paper, small shots, &c., and even powder alone, will produce a hole. But it is not possible from the mere examination of the weapon to be sure on this point. Any lead found adhering to the grooves of a revolver or rifle, need not necessarily have been from the last discharge. The report is said to be louder or sharper when the weapon is loaded with ball. The sharp, whizzing crack or hiss of a rifle-shot is not easily forgotten by those who have been exposed to danger from it. If there were any wall, or tree, or fence *beyond* the person fired at, the bullet or ball might, and indeed probably would, strike this, and be imbedded in it.

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* Mr. Ward, quoted by Dr. Taylor, records a case in which a red-hot poker inflicted a perforating wound of the skull, nearly half an inch in diameter, closely resembling a bullet wound. ["Med. Gazette," vol. lxiv., p. 767.]

4. You may be asked the *character* of the wound; in other words, *Is, or was it, mortal, or dangerous to life?* or calculated to do "*grievous bodily harm?*" The latter expression covers all those cases of injury to the eye, ear, nose, or other organ of sense, and injuries to the limbs, or generative organs, which cannot be described as dangerous to life, and still less as mortal. It also includes those cases in which there is considerable disfigurement of the face; or in ladies, of the shoulders, arms, and those parts of the bust which are uncovered in evening dress. Mutilations, again, of the fingers or toes must come under this description.

5. You may be asked, *How soon would such and such wounds kill?* Or how long would the wounded person take to recover? It is clear from what we have already said, that your answer must depend on the special circumstances of the case in question. We have, as each portion of the subject was considered in turn, met with cases of instant death, of death after three-quarters of an hour, or an hour; and of death after a year or two. Whilst in other cases, suffering has been protracted even forty years.

Questions of *survivorship*, if two or three persons are concerned, must be answered on general principles, such as those given at p. 610. Similar questions, affecting only the wounded man, or woman or child, can only be answered by a careful consideration of his or her injuries and surroundings. Some of these questions will be dealt with under "Wounds of Special Regions and Organs." ["Injuries to the Head, Chest, and Abdomen," &c.]

You may be asked, as to a gun, pistol, rifle, &c., *Has this weapon been fired lately?* It is not always easy to give a definite, and at the same time, true answer to this question. Gun-cotton, prepared sawdust, and some of the patent cartridges with gunpowder, leave scarcely any residue behind, the combustion being perfect. But with gunpowder, and especially in suicidal and homicidal cases, where the person who loads the gun or pistol is nearly sure to put some excess of powder, there may very likely be, and indeed often is, somewhat incomplete combustion. Dr. Guy says, (p. 294), "when the combustion of the powder is imperfect, the finger introduced into the barrel is blackened by the unconsumed charcoal; and the residue is found to consist of this unconsumed charcoal, mixed with sulphide of potassium.[*] But when the combustion is perfect, the finger is not blackened, for the residue consists of the white sulphate, and carbonate of potash. After an interval of some days, varying with the quantity of sulphur in the atmosphere, the mixed residue of charcoal and sulphide of potassium, becomes converted into sulphate—which, after a still longer interval, may be found blended with the rust of iron." This account is not only somewhat loose in its chemical phraseology, but gives us no directions how practically to examine fire-arms. Nor is Dr. Taylor's account, given at page 515, so complete as might be wished. He does indeed say that the sulphide of potassium forms an alkaline solution with water, evolving a smell of hydrogen sulphide [like rotten eggs], and blackening the acetate of lead. He also states correctly enough that the white sulphate of potash forms a neutral solution with water, and gives a white precipitate of sulphate of lead with plumbic acetate. He also refers to the "Ann. d'Hygiène," [1834, i. p. 458, *ibid.*, 1839, i. p. 197, and 1842, i. p. 368], and quotes the case of *M. Dujarrier*, whose death was carefully investigated in France. The question arose on this trial, whether by the mere discharge of powder, such a deposit of powder or charcoal took place at the mouth of the pistol as to soil the finger when introduced three hours after the alleged discharge. M. Boutigny's experiments were adverse to this view—and he considered that the sulphate and carbonate of potash were formed so rapidly that all the charcoal was consumed. But the facts proved on the trial overruled his experiments—and it seems clear that the quantity of powder used has much to do with the question. So also have its perfect or imperfect combustion, and the quality of the powder itself—the amount of charcoal in it—and perhaps the fineness or coarseness of the grain. [In firing large guns, such as the Woolwich Infant, little cakes, or cubes of powder are employed. A small fine grain-powder would never do. "Ann. d'Hygiène," 1848, i. 392.] *Sonnenschein* in his "Handbuch der gerichtlichen Chemie," goes more minutely into this matter of examining fire-arms. He admits that a determination of how lately a given fire-arm has been discharged, is often impossible. Yet we can often make a close approximation to the truth. Unless you have leisure to examine the gun or pistol at once, you should cover the end of the barrel, and wrap up the weapon in cotton wool. In examining it, begin with the outside first. If one of the old-fashioned flint and steel weapons [and a few such survive], you should examine the priming-pan first with a lens. If the weapon is loaded, the charge should be cautiously withdrawn. If there be a percussion-cap, remove this at once—and the same applies to cartridges. Save the cap, the cartridge, the powder, and the shot or bullets. Weigh the latter, and make drawings and measurements of the bullet. Count small shots as well as weigh them. Wrap up each article separately, and label carefully. Seal them up, and keep under lock and key. Examine the bore of the weapon, and other dimensions. Weigh it also. Measure its diameters. The bullet or shots may require analysis in some cases.* Examine the ramrod if there be one; also the lock, construction of the weapon, the pull of the trigger, &c. Look very carefully at any paper or other materials used as wads; also at the greasy matter used to lubricate. Newspapers may be used for wadding. Now wash the barrel thoroughly with distilled water, and filter the washings. Test the filtrate for sulphuric acid (by barium chloride), for alkaline sulphides (by lead solution), and for iron salts (by ferro-cyanide or ferri-cyanide of potassium). *If it be found that the bore of the barrel has a bluish-black colour, and contains no green crystals of ferrous sulphate, and no rust; but the solution has a pale yellowish colour, smells of hydrogen sulphide, and gives a black precipitate with acetate of lead solution, this indicates that not more than two hours have elapsed since the gun was fired.* If the barrel is less dark, and no rust or crystals are found, but there are faint traces of sulphuric acid from the barium chloride, *then more than two, but less than twenty-four hours have elapsed. If there are numerous spots of rust in the barrel, and if there are very clear re-actions of iron in the rinsings, then at least twenty-four hours have elapsed, and perhaps even five or six days.* The longer the weapon has been discharged, the more crystals of ferrous sulphate we shall obtain. *If there is a good deal of rust, but no iron re-actions in the rinsings, it has been fired some ten to fifty days.* [At least ten, at the most about fifty.] If the gun has been loaded immediately after firing, without being cleaned, the plug or ramrod shows a grey-black colour for the first four days in the cylindrical part; after that—say twelve to fourteen days—the colour is greyish-yellow, and the rinsings of the barrel show clear re-actions of sulphuric acid. If the barrel has been cleaned before being again loaded, the plug or ramrod is light-red, or ochre-yellow after one or two days; after that a darker red, and after twelve to fourteen days it is, and remains, greyish; the powder is coloured reddish by the iron rust; no re-actions of sulphuric acid can be obtained. If loaded again immediately after firing, the plug or ramrod is greenish, but soon assumes the darker colour described before. If the barrel be rinsed with whiting, this acquires a reddish colour. The following appearances are presented, by the dried or undried barrel respectively:—

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[*] The old *hepar sulphuris*, the liver of sulphur, a brownish or reddish-yellow, foul-smelling, especially if damp, substance of various composition: KS_2, K_2S_2, K_2S_3, K_2S_4, K_2S_5, also a sulphydrate HKS. There is very often carbonate and sulphate of potash in it; thus—$2(K_2S_5) + K_2S_2O_3 + K_2CO_3$, &c.

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* Lead is generally mixed with about $\frac{1}{50}$ of arsenic to make small shot. For bullets it is preferred pure. A cast bullet has a small hollow in its centre. As mentioned, one of Sonnenschein's cases had a large quantity of antimony in the metal of which the bullets were made. Tin, bismuth, and other metals, are sometimes added. And sometimes people melt pewter, and solder, and similar mixed metals to make bullets of them. Those used in the army are now punched out or pressed, and not cast.

	Dried.	Not dried.
One day after	Pale yellowish-red.	Yellowish-green.
Two to three days after...	A little darker.	Reddish-brown.
Four days after	Redder.	Redder.
Five or more days	Rusty.	Rusty.

Paper containing alum, or plaster of Paris, does not, when simply macerated in water, give the re-actions of sulphuric acid. These phenomena can only be verified when ordinary gunpowder has been used. *With gun-cotton*, the barrel is much corroded, and the ramrod will show a faint acid reaction, and sometimes various combinations of nitrogen (nitrates, nitrites, &c.,) may be detected by analysis. If chlorate of potash, mixed with some cyanide (or fulminate) has been used, there will also be a good deal of corrosion of the barrel; and the products of decomposition of these chemicals may be detected in most cases.

6. *Has the charge* (*bullet or shots*) *been deflected in its course*, or has it taken its ordinary course (trajectory)? We have before alluded to those cases in which a bullet, striking a rib, or some tense muscular aponeurosis, &c., is deflected, and only skirts a cavity. Dupuytren met with one case in which a ball skirted but did not penetrate the abdomen. Abernethy's case of a bullet going round the skull without piercing it, has also been noted before. But sometimes we can only answer this question by a careful examination of the surrounding buildings. Dr.

Taylor quotes a case from Mr. Watson, occurring at Ayr in 1831, in which several shots had been maliciously fired into a church. Some of the bullets traversed a window, making holes in the glass, and struck against a wall on the other side of the church—a fact plainly indicated by the marks left by them. A line was drawn from these two points, through the window, and reached a window on the other side of the street, from which it was afterwards ascertained that the shots had been fired.

In a case tried at the Kingston Lent Assizes, 1862, a similar piece of evidence clearly showed that a gun, loaded with a bullet, had been maliciously discharged with a design to kill one of two persons. The prosecutrix and her mother were sitting by candlelight near a window in their house, one evening, so that their shadows were on the blind; a bullet passed through the window, and struck the opposite wall. A line drawn between these points was about half-an-inch above the head of the prosecutrix, and about one inch below the level of her mother's head. Neither was hurt. Circumstantial evidence tended to criminate the prisoner. The defence raised by his counsel was, that he had gone out [in the evening] to shoot birds [with bullets], and the gun went off by accident! The judge directed the jury, very properly, to consider with what intent a shot could have been fired so close as to come within half an inch of the head of a person. The prisoner was convicted. And no doubt justly.

Sir Astley Cooper was able [*see* page 1091], by considering the line of fire to fix the crime of homicide on a left-handed person. In the same manner the death of *Charles XII. of Sweden* was judged to be from his own side, and not from the enemy. On the night of Dec. 11th, 1718, the king, who was besieging the fortress of Frederickshall, whilst examining the works, clambered up a mound, facing the enemy's batteries and within reach of their fire. Several noblemen were with him at various distances. Suddenly the king gave a deep sigh, and fell dead on the parapet, with his face towards the fortress. A ball had struck him in the right temple, traversed the brain from right to left, and forced the left eye from its socket. The direction of the wound tended clearly to prove that the king was not struck by a ball from the battery, which he was facing, but that this had been fired from some person on his right hand. Suspicion fell on a M. Siguier, who was then in attendance on him. Whether this was true or not, there was little doubt that the king was assassinated. [Taylor, *loc. cit.*, p. 669.] *He was found dead in the position in which he was struck, his hand on his sword.* In his pocket was a portrait of Gustavus Adolphus, and a prayer-book.

7. *Was the shot accidental, suicidal, or homicidal,* (murderous)? It is impossible to lay down any absolute rules by which you may answer these questions. Every case must be studied on its own merits. In general if you find several wounds [the contents of several barrels, or of one fired repeatedly], you may assume that the case was one of murder. But you must remember (1) that both barrels of a gun, or rifle, or two-barrelled pistol, or even more barrels in a many-chambered revolver, *may* go off accidentally; (2) That *one bullet has been known to produce five wounds,* (three of entrance, and two of exit*); (3) That a suicide

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* In a case of Dupuytren's, a ball struck the ridge of the tibia (leg-bone), and divided itself into two parts; both of which traversed the calf of that leg, and penetrated the opposite calf, lodging there; thus making the five wounds.

may, [and indeed suicides *have* done so] fire not once, but twice, and even three times in the attempt to take his own life. In general both accidental and suicidal wounds are inflicted at close quarters—but so may a shot intended to murder be. *A suicide* is most likely to hit the front of his body, to fire at his lungs, heart, head, &c. But some suicides have fired at the back of the head, or purposely arranged strings, &c., to pull a trigger to shoot them from behind. We have previously explained how ingeniously suicides fire a long gun with their feet or with the ramrod. The *murderer*, however, more often, unless furious with passion, *fires at the back or side of his victim.*

In Peytel's case ("Ann. d'Hygiène," 1843, i., 368), the military witnesses asserted that the two wounds were from two different pistols. With all deference to their opinion, we think it not impossible that the difference in the size of the wounds was caused either by two bullets of different size in the same pistol, both fired at one shot; or by different charges of powder; or different distances and height; so that the range and velocity differed. The prisoner alleged that the servant had only fired one pistol; and the military evidence being against this, the defence was overthrown. M. Ollivier supported the theory of two bullets in the one charge. In 1834, a tithes'-collector was charged with murdering a man by shooting him. The prosecution assumed that he took a deliberate aim from a distance. The dead man's son swore to it; a priest swore that the dying man, on his death-bed, declared this to be true. But on disinterring the body, a surgeon was able to swear positively that it was fired close, as there were marks of burning and of powder on the wrist. Hence the pistol probably went off in the scuffle, as the tithe-collector alleged. His statement was, that being on horseback, the deceased, and two or three more, tried to drag him off his horse; and that to frighten them he drew the pistol, when the trigger was accidentally pulled. He was acquitted, and the others convicted of perjury. *Mrs. Pearce*, a surgeon's wife, whose insane husband shot at her, had her dress burnt, and her skin blistered by the pistol being fired so close to her. [Central Criminal Court, 1840.] Mr. Marshall gives the case of a Cingalese sentry, who shot himself in the calf, to get his discharge from the army. His statement that he was shot by the enemy was disproved by the way in which his leg was *blackened* by charcoal. The calf was greatly lacerated and perforated also. Remember that *the same bore of weapon, and the same size of bullet, will produce wounds of different size at different distances, and with varying charges of powder*, consequently with different velocities. Beck mentions the following cases [p. 537]. The first from a French source. "An old man was fired at from a deep ditch on the road-side during a thick fog, and killed on the spot. A near relative, who was successor to his property, and whose menaces and conduct for some time previous were of an alarming nature, was suspected of the murder, and arrested. It was proved that a few minutes before the murder was committed, he was seen very near the fatal spot with a fowling-piece in his hand. On inspection by the surgeons, it was found that death had been occasioned by two balls, one of which cut the aorta across, and the other passed through the ileum. The hole in the ileum was perfectly circular, and when accurately measured, was found to be *eight* lines in diameter. The calibre of the prisoner's fowling-piece (the only weapon in his possession) was found to be only 6½ lines in diameter. This circumstance at once set the prisoner at liberty. But some time after this an old officer committed suicide by means of a cavalry pistol. The ball perforated the parietal bone, traversed the brain, &c. The hole where it entered was perfectly circular, and when accurately measured, was found not only greatly to exceed the calibre of the pistol, but, in fact, to admit, without much force, the barrel of the pistol itself. As regards the *direction* of the wound, the usual rules as to the diameter of the entrance and exit wounds will usually guide us. In one of Beck's cases, given by Dr. Gordon Smith, p. 290 [see also "Cyclopædia of Practical Medicine," art. "Persons Dead from Wounds," vol. iv., p. 561], the question arose, whether a person in company with smugglers was killed by his own gun, which went off accidentally when his foot tripped, or by a shot fired by a coast-guard. A navy surgeon found the wound in the upper part of the groin much smaller than that in the lower part of the buttock, and fragments of bone were felt at the hinder opening, but none in front. *He therefore gave it as his opinion that the ball had entered in front,* and therefore came from the coast-guard. Again, *Richard Annesley* was tried for the murder of *Thomas Englestone*, a poacher. The prisoner was in company with the gamekeeper, and he asserted that his gun had gone off accidentally in attempting to secure the deceased. It appeared from the evidence of the surgeon, that the *direction of the wound was upwards*, and consequently the fowling-piece had not been levelled from the shoulder. The jury brought in a verdict of *chance-medley*. ["English State Trials," Paris, vol. ii., p. 126.] In a duel, fought at Paris, in 1827, with pistols, *the person killed was much taller than his antagonist, yet the mortal wound was obliquely downwards.* Suspicion was excited, and an investigation made by Breschet, Denis, and Pressat. *The ball was found to have struck the clavicle obliquely, and in consequence of its resistance to have thus deviated.* They added, in their report, that they had witnessed many analogous cases. [Briand, 2nd edit., p. 298; Beck, p. 537.] How widely a bullet will deviate, we have already seen. It is well exemplified by the case quoted from Dr. Hennen, where the ball struck the breast, and lodged in the scrotum, the man standing erect in the ranks.

Professor Staughton (quoted by Beck) comments on the rotary motion imparted to rifle-bullets, causing them to make larger and more ragged openings than those of bullets from smooth bores. This is especially true of spherical bullets, which are now, however, seldom used. *The wound in the clothes is generally smaller than that in the flesh.*

The assailant or murderer *may use a weapon belonging to the victim.* It was so in *Reg.* v. *Wilson* [Shrewsbury Autumn Assizes, 1870] when a medical student was charged with shooting at his father, who was a medical man. The father was waked by two shots [two bullets were afterwards extracted, one from the eye, the other from his head]. On groping about, he found his own revolver on the floor. The son tried to make out that the father shot himself, but the wounds were evidently made from a distance. The question of *suicide* or *murder* is sometimes much complicated by the discovery of motives or circumstances which might be motives for the crime. It was so in the case of *Risk Allah.*

Accidental wounds are generally *near wounds*, but so again may homicidal ones be. In the shooting season many accidents occur from carelessness with guns in getting over hedges, &c. A Cambridge Professor and M.P. is stated to have lost both eyes from the accidental discharge of a double-barrelled gun, carried by his father (who was before him). People often kill themselves in this way, when the muzzle points towards them. In such a case the wounds may be behind if they pull or drag a loaded gun through a hedge or gap, or over a stile. How the accident happens in some undoubted cases of misadventure is not always known. Dr. Taylor gives the case of a Scotch barrister, who lay down to sleep, the muzzle of his gun being close to the back of the calf of his left leg, pointing in a slanting direction downwards. Somehow the gun went off in his sleep, and produced a large irregular wound of all the fleshy part of the leg; there was no round hole as usual with small shot at close quarters. The leg of the trowsers was much burnt as well as torn. Sometimes small shot is thus carried, *en masse*, into a wound.

Another case is quoted by Dr. Taylor, of the Station Master at Dover (*Mr. Walshe*), shot by a man called Wells in May, 1868. The bullet traversed the head, and entirely destroyed the nose. *The entrance aperture* was so large as to admit three or four fingers; it passed out behind, splitting the occipital bone, and was found in the room with a stain of blood and some hairs on it. The bullet only weighed 250 grains; it was therefore smaller than a Minié, though of the same pattern.

8. You may be asked—*Was the wound inflicted during life, or on the dead body?*

In cases where no large artery is wounded, the appearances of the wound, if inflicted soon after death, may be almost identical. In the absence, however, of any other sufficient cause of death, a gun-shot wound, penetrating any important region, must be judged the cause of death, and therefore inflicted in life. When there is much hæmorrhage we shall of course decide that the wounded person was alive, by finding clots, or coagula, by the staining of the tissues, and by the blood lost. After death the bullet will have to traverse a large vein to cause hæmorrhage of any moment. You will remember, too, that the living skin and muscles are more elastic and resilient than dead ones. Here, for the present, we must close our remarks on gun-shot wounds. A few additional cases will be found, along with histories of other wounds, in the Illustrative Cases at the end of the chapter.

Wounds of Special Regions.

We shall, for the sake of simplicity, divide these into four classes, viz.:—

I. Wounds of the Head, and Neck, and Spine.

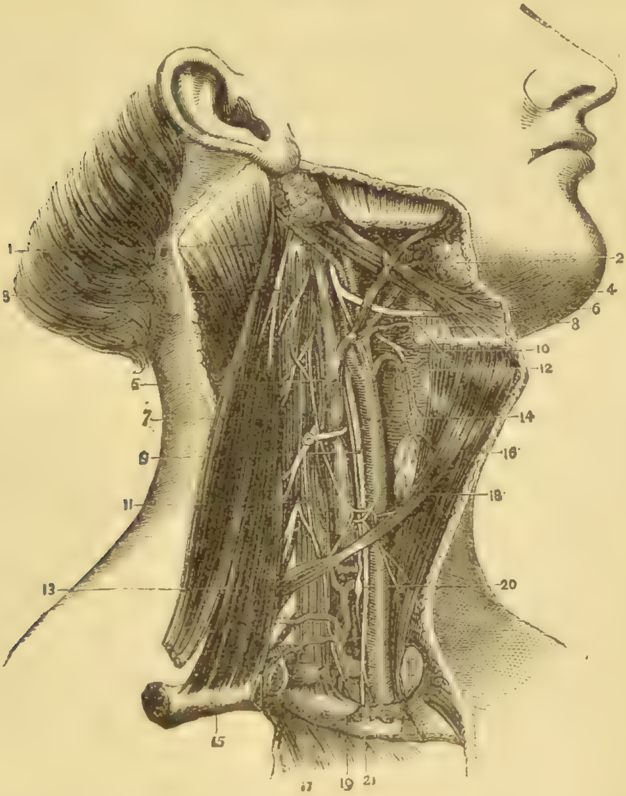
II. Wounds of the Chest, including those of the Lungs and Heart.

III. Wounds of the Abdomen, including injuries of the Chylo-poietic Viscera, Pelvic Organs and Genitals.

IV. Wounds of the Limbs (Arms and Legs).

Wounds of the spinal-cord, and its membranes have been taken in the first class as a matter of obvious convenience; because in this way injuries of the nervous system are nearly all arranged in one group, the exceptions being injuries of the sympathetic nerves, which have as yet but small bearing on forensic medicine. The first point that occurs to one in *Injuries of the Head, and Neck, and Spine*, is the immense importance of these regions, not only to life, which they share with other parts, but to all that renders life valuable or enjoyable. In the brain we have nearly all the organs of sensation, the nerves for sight, smell, taste, and hearing; and, if we include the neck, not only the nerves, but most of the apparatus for vocal speech. Adding the spinal cord, we get the sense of touch, or common sensation, and the power of locomotion; and all the marvellous endowments of the human hand are derived from the brain and spinal cord as centres. A reference to figs. 108, 109, and 110 [pp. 881-2], will show most parts of the brain, including the cranial nerves. The figure in the text [fig. 115] gives a good idea of the important structures contained in the neck. The clavicle or collar-bone (15) is sawn through in two places, and turned to the right, so as to reflect the clavicular part of (13) the sterno-cleido-*mastoid* muscle.

FIG. 115.



(1) Is the *occipital artery;* (2) The *facial vein;* (3) *Spinal division of the spinal accessory nerve* (part of eighth pair), giving branches to the sterno-mastoid and trapezius muscles; (4) The *facial artery;* (5) The *internal jugular vein* [see Illustrative Cases for an account of a case in which this was tied]; (6) *Hypoglossal nerve,* or nerve of motion to the tongue; (7) *Communicans noni nerve;* (8) *Lingual artery to the tongue;* (9) *Pneumogastric, or vagus nerve;* (10) *Superior laryngeal nerve;* (11) *Phrenic nerve,* or motor nerve of diaphragm; (12) *Superior thyroid artery;* (13) *Sterno-mastoid muscle,* turned back, see above; (14) *Common carotid artery*

[from which the *external* and *internal carotids* are derived]; (15) *Clavicle or collar-bone*, turned back, see above; (16) *Sterno-hyoid muscle;* (17) *Sub-clavius muscle;* (18) *Omo-hyoid muscle;* (19) *Thyroid axis*, from sub-clavian artery; (20) *Middle cervical ganglion* of the sympathetic nerve; (21) *Sub-clavian artery.* [This drawing is by J. T. Gray, and is the same as that given by Dr. Taylor, p. 488.] Severe suicidal or murderous wounds of the throat often involve the greater number of the structures named, on one or both sides of the neck. For the sake of system we must, however, treat first of—

Injuries to the Head, including Concussion and Compression of the Brain.

As the two last-named conditions are common to many forms of cerebral injury, and may be associated with wounds and fractures, or exist independent of any external marks of injury, it will be convenient to notice them before describing the other lesions. We will begin with—

1. *Concussion of the Brain.*—This is liable to be confused with intoxication, with compression of the brain, with opium-poisoning, syncope, coma from various conditions, sun-stroke, &c. &c. It is a very common result of sudden injuries to the head, such as a violent blow, or a fall in which the head is struck. There need be no external wound. The symptoms are not unlike those of *shock* in injury to other organs, or *collapse*, only that in concussion consciousness either is, or appears to be entirely lost at first, and suspended for a considerable time. The symptoms may come on immediately, and generally do so. In other cases there is a short interval between the accident and the supervention of the symptoms. Druitt * makes two degrees of it.

"(1) In ordinary cases the patient lies for a time motionless, unconscious, and insensible. If roused and questioned, he answers hastily, and again relapses into insensibility. After a time he moves his limbs, as if in uneasy sleep, and vomits; and frequently recovers his senses instantly afterwards; remaining, however, giddy, confused, and sleepy for some hours.

"(2) In the more severe degree the patient is profoundly insensible, surface pale and cold, the features ghastly, the pulse feeble and intermittent, or perhaps insensible, and the breathing slow, or performed only by a feeble sigh, drawn at intervals. *Vomiting* is an important symptom. It is not present in very slight cases, nor in very severe ones; and its occurrence is mostly an indication of approaching recovery."

This condition may terminate fatally, after a few hours, or after some days. It really means *contusion*, as Mr. Prescott Hewett and Dr. Druitt insist. Dr. Bright long ago pointed out minute ecchymoses, the size of pins' heads, in fatal cases of this kind. There is also more or less laceration of the brain substance; and injuries of the spine, and of other organs, such as the heart, are often found associated with it. *Or there may be recovery*, with but little damage, except headache, and slight fever for a few days. *Or prolonged insensibility* may last for many days, the patient lying as if asleep; but when excited, the carotids pulsate rapidly, the pulse beating 140 or 150; and if roused, he may answer questions. Some of these patients may resemble somnambulists: they will get out of bed to make water, or go to the closet, or they will bolt the door, shave themselves, take food in a mechanical way (when fed, or when the food is close to them), yet still appear insensible to all around them. One of the Authors knew such a condition to last twenty-one days in a quarryman, who ultimately recovered perfectly, with no paralysis or impairment of brain functions. *Or recovery may be imperfect,* loss of memory, an imbecile constitution, or state of dementia, or enfeebled intellect, loss of sexual and bodily power, and impaired sight, hearing, and other nervous functions, may be the results. The consequences of concussion of the brain greatly depend on the mode in which the injury is inflicted. A sudden violent shock may stop the heart at once, and prove fatal; or inflict injuries on the brain, which may be irremediable;* whilst a more gradual and less violent injury may be far better tolerated. Mayo showed that if you suddenly crush a very small part of an animal's brain, the heart stops at once, whilst nearly the whole brain may be gently sliced away, with little or no effect, except loss of special functions. Mr. Guthrie (in "Injuries of the Head," &c., London, 1842, p. 11) strongly deprecated any very active measures in the treatment of concussion. The patient should be left quiet to recover, in most cases, though friction and warmth to the feet sometimes seem useful. [One of the Authors has used artificial respiration in a few cases.] Advantage, as Miller well says, should be taken of this condition to examine for other injuries, such as broken bones, dislocations, and wounds.

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* "Surgeon's Vade Mecum," p. 333.

Concussion, especially when the brain or its membranes are much lacerated, may be followed by meningitis and encephalitis. For the symptoms of these, and the after-treatment of concussion, we must refer to the articles on this subject in Erichsen's, Miller's, Druitt's, Pirrie's, and Bryant's "Manuals of Surgery," to the articles on "Concussion and Injuries of the Head," in Cooper's "Dictionary of Surgery," and Holmes' "System of Surgery," and to the monographs of Prescott, Hewett, Guthrie, Sharp, Hilton, and others. See also the opinion of Chassaignac, Langier, and Robert, quoted in Ranking's "Abstract," vols. ii. and iii.

Concussion may prove fatal at the moment. Thus a man may fall on the pavement from tripping his foot, and be picked up dead. See also South's Chelius' "Surgery," vol. i., p. 408. This may depend entirely on nervous shock. Sudden death occurred in the case of *Regina* v. *Burgess* (Liverpool Lent Assizes, 1845). Consciousness is sometimes present, when supposed to be absent. Dangerous or fatal symptoms may come on several days, or even weeks, or perhaps months, after the concussion and first injury. [Dr. Taylor refers to "Medical Times and Gazette," June 30, 1860, p. 645.] The Authors knew a case in Torquay, where some thieves attacked a gardener on his return from market, and knocked him about the head. He did not suffer any serious symptoms from it, but did his work for six weeks. He then began to get ill, and died from it after about five weeks more. An abscess of the brain was caused by the blows. In such cases it is often alleged for the defence, that there must be some intervening cause, or some second injury or violence. The experience, however, of practical surgeons quite contradicts this. [See *Regina* v. *Kelper*, Lewes Summer Assizes, 1871; also Travers' "Constitutional Irritation," p. 445; Hoffbauer, "Ueber die Kopfverletzungen," 1842, p. 57. Taylor, p. 617; and the works quoted above.] In some of the severer cases of concussion, the spine or the base of the brain, may be severely injured. In the Duke of Orleans' case the base of the brain was fractured by a fall. ["Med. Gazette," vol. xxxvi., p. 368.]

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* Dr. Druitt adds a foot-note to this effect:—"The blunt, heavy dragoon sword of the English will not penetrate the head-dress of the Sikh or Afghan; yet the enemy is mostly beaten from his horse, and frequently killed by the violence of the shock. The trenchant blade of the Sikh, wielded by a strong man, will cut through any head-piece, and perhaps bury itself in the brain; and yet you find no symptoms of concussion or compression. In the former example, the soldier is effectually disabled, often killed outright; in the latter, though mortally wounded, he may be able to continue the fight, and even to kill his antagonist, before he himself falls dead or dying from his horse." (Cole's "Field Practice in India," p. 45. See also a very able paper by Dr. R. C. Williams in the "British and Foreign Quarterly," January, 1853.)

We shall return to the question of diagnosis, after reviewing the symptoms of compression.

2. *Compression* of the brain is the result of either extravasation of blood, or blood and serum, within the brain, with or without fracture of the skull, or of the pressure of depressed bone in fractures, and severe contusions, or of suppuration occurring within the cranium. The symptoms are essentially those of *apoplexy*. There is *insensibility* (coma); *paralysis*, either one-sided, or general; *dilated** and *insensible pupil* [the pupils are often unequal]; *slow labouring pulse; skin often hot and perspiring*, *retention of urine*, or involuntary evacuation of this, and of fæces, through paralysis of the sphincters; *stertorous breathing* (due to paresis of the *velum pendulum palati*). There may be *convulsions* or *twitchings*. as well as paralysis, and usually on the opposite side to the paralysis. The paralysis may involve the muscles more or less deeply, or may be confined to special nerve-tracks. Thus we get—(1) Hemiplegia, with paralysis of one side of the face; (2) Facial paralysis alone, or with anæsthesia (loss of sensation, due to the fifth nerve; the *portio dura* of the seventh pair producing the facial paralysis); (3) We may have paresis of the ocular muscles; ptosis, or dropped (upper) eyelid, with various forms of squint [third, fourth, and sixth, nerves]; (4) There may be complete paralysis on both sides of the body (double hemiplegia); or, (5) Paraplegia, paralysis of the lower extremities; and (6) Of the sphincters.

Compression generally comes on after symptoms of concussion. Indeed, after the first shock, the patient often rallies for a time, sometimes even for some hours. Then the symptoms described come on, at first like apoplexy of the ingravescent form; the injured man seems drowsy, and wants to sleep. These symptoms may be mistaken for poisoning by opium and other narcotics, for drunkenness, and for apoplexy. No surgeon who has studied at a large hospital, ought to confound them with concussion, except in a few rare cases, where the symptoms are equivocal. The extravasated blood may be—(1) Between the skull and the *dura-mater;* (2) Between the membranes; Mr. Prescott Hewett says, extravasation into the cavity of the arachnoid is very common in injuries of the skull. Hence, perhaps, *arachnitis,* as Mr. Hutchinson has shown, is one of the commonest forms of *meningitis* *; (3) The extravasation may be in the substance of the brain itself. Some eminent surgeons have objected to the use of the term *compression,* and doubted if such a thing really existed. We cannot do more here than refer to the experiments of Dr. Kellie, and the later and more accurate ones of Dr. Burrows on the quantity of blood in the cranium. The former will be found in the "London Medical Gazette," for May, 1843; the latter in Dr. Burrows' work, "Disorders of the Cerebral Circulation," 1846. Most manuals of physiology contain abstracts of these. For some experiments of Dr. Brown Séquard bearing on this point, see his "Lectures," in the "Lancet," and other medical journals, since 1858. All we can well say here is, that both clinical experience and experiments tend to show that the quantity of blood in the cranium may vary considerably. In any case the term "compression" is a convenient term for the group of symptoms described above. If the blood-vessels of the brain are found diseased (atheroma, or mineral degeneration), the objection may be raised that the case is one of apoplexy. The following case (given by Beck, in a footnote to p. 625) is, at least, curious: "He says, that amongst Sir James Mackintosh's books was a pamphlet, entitled, 'An Appeal to the Public, touching the Death of Mr. George Clarke, who received a Blow at Brentford on the 8th of December, of which he languished and died on the 14th. By John Foot, Surgeon, London, 1769.' Mr. Clarke was struck on the head by Edward McQuirk during some election riots, the weapon used being a bludgeon. The wound bled profusely. On his way home he felt faint, and took some brandy. He went to bed, and his symptoms gradually became aggravated. He was bled on the 10th, but without any improvement. On the 12th an apothecary, called in, found him in a violent fever, with delirium. He applied remedies; and on the next day Mr. Bromfield, the surgeon, was sent for, but does not appear to have prescribed. Clarke died in the night. Mr. Foot was called in to examine the body before the coroner's jury. He desired the aid of Mr. Bromfield, who refused to come, 'because he apprehended it might be an Old Bailey business.' There was a contused wound on the head, by the side of the sagittal suture, upon the right parietal bone; the scalp was elevated for a considerable distance around; the wound and the pericranium was much inflamed, and separated from the skull. On removing the calvaria, the dura-mater, immediately under the part where the injury was inflicted, was found greatly inflamed, and detached from the bone. Between it and the pia-mater was a quantity of coagulated blood. The pia-mater was inflamed, and some of its vessels ruptured. There was no fracture." Mr. Foot, therefore, concluded the wound was the cause of death. It appeared at the trial that Clarke was a healthy, temperate young man.

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* The pupils are sometimes *contracted*, especially in large extravasations, or those about the Pons and fourth ventricle.

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* The meninges of the brain, in other words, its membranes, like those of the spinal cord, are threefold—(*a*) The *dura mater*, or external fibrous thick coat; (*b*) The *arachnoid*, or the serous coat, generally supposed to be like a double nightcap, investing both the dura mater and the brain, or rather pia-mater; (3) The *pia-mater*, or vascular membrane investing the brain itself, and dipping down between its convolutions.

McQuirk was found guilty. Soon after this the case was referred to the Court of Examiners of the Surgeons' Company, on the ground that neither Mr. Bromfield nor the apothecary had been examined, and that Mr. Foot only saw him after death. The Court (without assigning any reasons) gave, as their opinion, that Clarke did *not* die of the blow. McQuirk received a full pardon.

Percival Pott was a member of this Court; and Mr. Foot refutes this dictum from Potts' own *Memoir on the nature and consequences of those injuries to which the head is liable from external violence.* With Foot and Beck we fully agree, that the first verdict was the right one.

The various injuries of the head referred to will be better understood by the following scheme of the different layers from without inwards. There are, in fact, three complex layers, viz. :—

A. The *outer layer*, or *hairy scalp*, containing—(*a*) the *hair* and *skin*, with its epidermis, rete mucosum, and corium [*see* p. 1073]; (*b*) the *muscles* of the scalp [occipito-frontalis, complexus temporal muscles, &c.]; and (*c*) the *peri-cranium*, or external layer of periosteum.

B. The *bony skull*, or *cranium*, consisting of the frontal, two parietal, two temporal, and occipital bones, with the sphenoid bone, each bone being made up of—(*a*) an *outer table* of compact bone; (*b*) intervening *diplöe*, or spongy cancellous bone, very vascular: absent in young children, and in very old people; (*c*) the *inner table*, or *vitreous* plate of compact bone, very brittle and glass-like.

C. The *membranes*, consisting of—(*a*) the *dura-mater*, or external thick, fibrous membrane, which is really the internal periosteum or pericranium; (*b*) the *arachnoid* or serous membrane; (*c*) the *pia-mater*, or vascular membrane, dipping down deep between the convolutions of—

D. The *brain* itself.

The spinal cord has similar membranes, and is enclosed in a bony case, formed by the vertebræ. Outside this are muscles, and then comes the skin. In the *brain*, however, the *grey matter*, or true nerve-cell layers, are on the outside chiefly. In the *spinal cord* most of the *grey matter* is in the interior of the cord. The brain and spinal cord, though centres for sensation, are themselves almost devoid of feeling. *The differential diagnosis of compression of the brain from apoplexy*, is almost entirely dependent on the history. In the latter there is no accident, and no marks of external injury; whilst in compression of the brain there is generally a history of accident, and marks of external injury. Yet cases are constantly occurring in which the compression depends upon *fracture of the skull*, which can only be detected *post-mortem*, there being no external signs of injury. Such *fractures of the skull* are usually of the base of the cranium. In some of these cases, besides the history of an accident, and the symptoms of compression just given, we have a discharge of cerebro-spinal fluid [often containing sugar] from the ear, extravasation of blood into the conjunctivæ, and into the tissues of the orbit. There may be free bleeding from the ear on one side, the blood coming from the diplöe, through the lacerated or absent membrana tympani. Deafness will point to the auditory nerve, facial paralysis to the portio dura; as does inability to close the eye, &c.; loss of sensation in the face and tongue to the fifth nerve; strabismus, ptosis, and dilated pupil to the third nerve; inability to move the tongue to the ninth; difficulty in swallowing, and stertorous breathing to the eighth pair, &c. &c.

Compression is very like drunkenness. There are some cases in which it is not possible to distinguish one from the other at certain stages. Concussion, also, resembles the effects of alcohol. The man whose brain is injured, or whose skull may be fractured, may have had brandy given him, and his breath may smell of it. Again, the brain-lesion may involve both sides. The same difficulty is met with as regards apoplexy and drunkenness, and some forms of opium poisoning. The following signs may make us *suspect* that we have to do with alcoholic coma, or dead drunkenness, and not with apoplexy, or compression of the brain, viz.:—The temperature being greatly lowered; instead of 98·6° F. [37° C.], we get 95°, 90°, or 87° F. [35°, 32·2°, 30·6 C.]; the loss of power (paralysis), and loss of sensation (anæsthesia), instead of being unilateral, are symmetrical, *i.e.* on both sides, and almost total; the bladder is generally full of limpid urine, of low specific gravity, almost colourless, and furnishing on distillation, a large amount of spirit. A single drop gives a bright green with the bichromate solution [300 of sulphuric acid to 1 of potassium bichromate]. There is generally less stertor than in apoplexy, or fracture of the skull. The pupils are sometimes contracted, and sometimes dilated. On the other hand, all these symptoms may, though rarely, be met with in apoplexy, and fracture of the skull. *Doubtful cases of this kind ought not to be left to the diagnosis or treatment of policemen*, or shut up in a *police cell*, as so many have been, with *almost certainty of death.* All cases of complete unconsciousness ought to be carefully examined by a medical man, and to be treated in hospital, unless skilled assistance can be had in their own homes; for, although medical men may not be able to make a certain diagnosis at the moment, yet in a short time symptoms may set in, which will not only settle the nature of the case, but give indications for treatment. And in a large number of cases a skilful medical man can make a diagnosis; whereas, the policeman relies solely upon the one test of the smell of alcoholic liquor, which we have shown to be fallacious. Scarcely a week elapses without a case of apoplexy, or injury to the brain, being mistaken for drunkenness, and locked up in a police-cell; where such cases usually die, unless the authorities, becoming alarmed, remove them, when too late, to some hospital. In cases of opium poisoning, and death from chloral-hydrate, and other narcotics, the symptoms may be very similar to those of apoplexy of the pons varolii, or of a large extravasation of blood, pressing on both sides of the brain. In all these cases the pupils are contracted; we get almost absolute loss of motor power and of sensation, with stertor, coma, and other symptoms, common to all these conditions. An examination and analysis of the vomited matters, or of the contents of the stomach, or of the urine, may sometimes show us the nature of the case. And sometimes the breath by its odour will reveal the poison, as in prussic acid poisoning, and its compounds.

Blood may be extravasated as a result of excitement, without any blow or injury. See p. 1081. Many other cases are given in Taylor [*loc. cit.*, p. 624, &c.]. Where one or more blows are also struck, and marks of violence are visible, it is not always possible for a medical witness to say whether the excitement or the blow caused the extravasation. If the injury be very severe, it is not unreasonable to blame the violence;

whereas if the injury be slight, and the excitement great, the latter probably deserves the blame. The blood vessels will generally be found very diseased in such cases. Granular kidneys, hypertrophy of the left ventricle of the heart, and diseased blood vessels, make a trio of very common occurrence in advanced life; and here we have all the conditions for apoplexy, or for serious results from blows and fractures. We may sometimes be sure from a post-mortem examination *that the extravasation of blood*, or *serum*, or *the lymph effused, are of older date than the alleged injury.* The blood-clot may have become paler; its pigment may have crystallised. We may find cholesterin, we may find an adventitious cyst or sac round the hæmorrhage, or there may be cicatrices, and contraction of the brain substance, or softening, or the lymph may have become partly organised—all changes which require time—many days—usually several weeks being necessary. In *Reg.* v. *Phipps* [Gloucester Summer Assizes, 1845], Mr. Justice Patteson said that if two men were fighting, and blows were struck, and one fell to the ground and died, and afterwards injuries were found internally corresponding to the external marks of violence, no power on earth could persuade him that such blows were not the cause of death! The prisoner was found guilty. He had struck the deceased a severe blow under the left ear, and a recent extravasation of blood was found at a corresponding part inside the skull. Although the judge's dictum may have been too absolute, yet a medical witness ought to have strong reasons for attributing death to other causes when there is such a strong appearance of cause and effect. Besides, it seems to us, that the excitement produced by a struggle is just as rightly attributed to the assailant (in most cases) as the result of a blow. His cause may be the just one, but the blow also may be given in self-defence [justifiable homicide]. Dr. Taylor quotes from Dr. J. Reid's "Physiological Researches," p. 513, a case of a woman aged seventy throwing herself from a window. Thirty-one days after the injury she died, and in the brain the extravasated blood was brownish, or chocolate-brown, in one part; almost black in another. In the legs and chest the blood extravasated was still blackish and recent-looking. The fracture of the sternum had united. This and other cases should make us cautious in assigning dates to such extravasations.

The skull may be fractured without wound of skin. [*Reg.* v. *Ward*, C. C. Court, 1841.] *It may be fractured from indirect violence* [fracture by *contre-coup*], as when the base is fractured from a blow on the summit, or one part of the skull from a blow on another part, or the base from the condyles of the lower jaw being violently forced up against the glenoid fossæ of the temporal bones.

One table only may be fractured, or a small punctured wound of the outer table may cause great depression and splintering, and extensive fracture of the inner table. This, which seemed very marvellous to our ancestors, is simply dependent on ordinary mechanical principles, for when the force is applied from within (as by a bullet shot through the mouth), then the outer table is most splintered, and its wound is the larger. *Be careful not to mistake Wormian bones, or natural sutures, for fracture.*

The brain may be wounded without fracture. Mr. Needham has told us of a case of Mr. Rivington's in which the stem of a clay tobacco-pipe was forced through the orbit, passed along the sphenoidal fissure and the cavernous sinus, and lacerated the brain, producing abscess of the brain in about a fortnight. Sir Astley Cooper mentions a girl who, in play, fell on a pair of scissors, and one point fractured the orbital plate of the frontal, and lacerated the brain.

The celebrated comedian, Macklin, was tried in 1735 for having caused the death of Thomas Hallam by thrusting a stick into his eye. Very recently a major in the artillery, in defending himself with his umbrella against some street roughs, thus caused the death of a man, aged twenty-one, by the umbrella point going through the orbit into the brain. He was exonerated by the jury at the inquest. Macklin was found guilty of manslaughter. Hoffbauer [" über die Kopfverletzungen," 1842, p. 49] mentions another tobacco-pipe case. Dr. Taylor (p. 631) gives many others. *The orbit and neighbourhood of the eye* are, therefore, dangerous spots as regards the lesion, on account of the natural openings, and of the thinness of the bones. *The neighbourhood of the ears* is dangerous for a similar reason; and cases of sudden death from blows in this situation might be quoted in considerable numbers.

Wounds of the eye and ear are not only dangerous from the proximity of the brain, and the risk of meningitis, cerebral abscess, &c., but they are liable to be followed by loss of sight, or loss of hearing. Loss of sight in one eye often affects the eye of the other side, sympathetically, unless the whole eyeball be removed. *Wounds of the nose* may cause injury to the brain, and are considered especially liable to erysipelas and tetanus; wounds of the face may produce great deformity; and injuries to the *antrum of Highmore* in the upper jaw-bone may implicate the brain.

As regards the special *symptoms due to injuries of particular parts of the brain*, we must refer you to the works on injuries to the head previously mentioned, and to numerous papers by Drs. Brown-Séquard, Ogle, Broadbent, Hughlings Jackson, and others in the medical journals of the last fifteen years; to the works of Claude Bernard, Ferrier, Charcot, and Hitzig ;, and to an excellent summary of these by Dr. R. Lepine, entitled, " De la localisation dans les Maladies cérébrales," Paris, 1875. Recent lectures by Dr. Brown-Séquard at the London and Dublin Colleges of Physicians (*see* the medical journals for 1876) render it necessary for us to speak with extreme caution on these points. Almost all that we can safely say is that in many cases the injury to the brain is on the opposite side to the paralysis—that injury to the corpus striatum, optic thalamus, and adjacent parts, is usually followed by hemiplegia—that loss of speech is most common in lesions of the third frontal convolution and thereabouts (" Broca's Region," *see* p. 882), and that the parts named, and the medulla oblongata, pons varolii, and third and fourth ventricles, are regions which cannot be injured without the greatest risk to life, the centres of respiration, deglutition, and the regulators of the circulation being situate in and about the medulla oblongata and floor of the fourth ventricle, this region being termed the *vital knot*. So that animals may be killed instantly by *pithing* or stabbing this region between the last vertebra and the skull. Injuries of this part lead also to glycosuria and diabetes. Vomiting is a frequent symptom in all brain lesions, especially those of the cerebellum.

When the spinal cord is cut across or otherwise damaged, we get the following symptoms, one-half only of the cord (in a horizontal direction) being supposed to be cut across or injured :—

On the same side as the injury.	On the opposite side.
Loss of motor power (partial or complete).	Loss of sensation (partial or complete).
Hyperæsthesia, or increase of sensation.	Voluntary motion nearly normal.
Temperature raised.	Temperature diminished.

It is understood that the section is below the decussation of the motor fibres at the anterior pyramids. All parts *below* the section are affected. Priapism is a common symptom in injuries of the cord. Injury in the neck and chest causes difficulty in breathing. Pain and reflex movements may persist. And the sphincters are usually paralysed at the same time. The Authors have known the spinal cord completely cut through by a stab with a knife, which passed obliquely from a distance of more than four inches from the spinal column [*see* "London Hospital Reports," vol. iii., pp. 324—356, and ibid., vol. i., p. 374; "London Medical Record," Jan. 1877].

The spinal cord may be compressed by dislocation of the vertebræ, with or without fracture. The ligaments, however, are usually broken in these cases. This accident may happen (1) in railway collisions [*Bowling* v. *South-Eastern Railway Co.*, Exchequer Court, Feb. 1859; *Williamson* v. *London & Brighton Co.*, Guildford Summer Assizes, 1862]. (2) In violent struggles, by the forcible bending back of the head, &c. [Dr. King's case, of Glasgow, reported by Dr. Taylor, p. 622]. (3) By fall of heavy bodies from above accidentally. The Authors knew a case in a miller from a sack of flour falling on his head. [*See* also Taylor, *loc. cit.*, p. 633.] (4) By ignorant bone-setters, &c., forcibly twisting the neck, as in the case of torticollis reported in the "Gazette Médicale," Nov. 1842. *See* also "Henke's Zeitschrift der S. A. 1840," 2, 407, and "Annales d'Hygiène," 1871, 1, 138; 2, 116. Other consequences of injury to the spinal cord and brain will be found mentioned at pp. 911—16.

Fractures of the skull may be *simple* (*i.e.*, without communicating with any wound), *compound* (or communicating with a wound), *comminuted* (*i.e.*, broken into fragments), *depressed*, &c., &c. If produced by a sabre-cut descending perpendicularly, musket-shots, blows with pokers, or other weapons, particularly the small end of a hammer, or pickaxe, the *inner table may* be injured far more than the outer, as remarked at p. 1138. What is known as "Pott's puffy tumour" [*see* diagram and description in "Miller's Practice of Surgery," p. 34] is a swelling of the scalp indicative of suppuration between the skull and the dura-mater. But the name has been occasionally misapplied to the immediate effect of a blow on the scalp, without fracture, where there is sudden, somewhat circumscribed swelling, and *depression in the centre*, which an incautious observer might take for a depression in the bone.

Hernia [or *fungus*] *cerebri* is the protrusion of a granulating portion of brain through a fractured skull, which may happen during the course of such a case as that mentioned at p. 1087.

For the *treatment of these injuries of the head* we must refer you to the works already quoted. Opinions differ as to the propriety of *trephining*, or trepanning, in certain cases of fractured skull. The majority of modern surgeons hesitate to do this in the case of very young children with fractured skull. It is, however, doubtful if the risks are much increased by the operation itself when the fracture is compound.

As regards *laceration of the scalp*, and *contused* and *incised wounds* of the same, without fracture, there is no doubt that the risks are greater than those of wounds of the skin in many other parts. There is not only more risk of *erysipelas*, but there is always more or less danger of *injury to the brain* supervening, if, indeed, it do not accompany the original injury. Yet hundreds of scalp-wounds are treated at our large hospitals every year which never give rise to very serious symptoms.

Besides injury to the spinal cord in the neck, which we have just been considering, there is risk to the *larynx*, or organ of the voice, and to the *phrenic*, *vagus*, *sympathetic*, and *fifth nerves*, by forcible compression of the neck. *Pressure on the carotids* (such as is produced by the well-known policeman's grip, by inserting the fist inside the collar and pressing against the throat with the knuckles) may produce temporary insensibility, and if prolonged, death. The explanation is partly the interrupted blood supply to the cranium; and partly, no doubt, the pressure on the vagus and other nerves shown in Fig. 115. The inner coat of the artery may be injured by forcible *knuckling*.

The most serious injuries to the neck and throat are produced in what are called *cut-throat* cases. Both suicides and murderers inflict the most frightful injuries on this part of the body. The weapons commonly employed are sharp table and carving knives, razors, pen-knives, and "bowie" knives. A woman was admitted to the London Hospital in 1861 who had cut her throat with a table-knife so severely as to cut the windpipe entirely through, and wound the pharynx and œsophagus. She cut through the muscles covering the spine, and cut deeply into the inter-vertebral substance of three or four of the lower cervical vertebræ. There was frightful hæmorrhage, but the knife being a little blunt, had pushed the jugulars and carotids back or to one side, so that only one carotid was wounded, and that slightly.* The Authors know of another suicidal case, in which a lunatic nearly severed his head from the body.

In *such suicidal wounds of the throat the deepest part is usually the beginning of the wound*, and consequently on the *left side*, in right-handed people, and the wound finishes off by a tail-end, involving little more than the skin. Very often the last part of the wound, or that to the right, presents several gashes or jags. Sir Everard Home thought that *regularity* in a wound, *i.e.*, its being clean cut and even, pointed to suicide. The Authors, from their own experience, cannot agree with this view. Dr. Taylor remarks that the wound in the throat of Lord William Russell, who was murdered by Courvoisier, in 1840, "possessed all that regularity which has been so improperly regarded as characteristic of suicide" [*loc. cit.*, p. 485, vol. ii.]. How, then, shall we judge whether a wound in the throat or neck be homicidal or not? The answer seems to us to be, not from the mere wound itself (except where a right-handed person has inflicted a left-handed wound, or *vice versâ*), but from the presence or absence of other injuries—for example, fractured ribs, or cuts on the hands, and wounds in other parts; from evidences of a struggle having gone on, such as torn clothes, disordered furniture, blood spots, or marks on the ground indicating a body having been dragged for some distance, hairs being torn from the head of the injured person, or from the head, beard, or whiskers of the assailant, marks of contusions in either person, and other similar circumstances.

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* Dr. Ryan quotes a similar case in the "Medical Times," Jan. 17, 1852, p. 73.

Except from broken glass, wounds of the throat are not very often purely accidental. But if a person has an open knife in the hand, and another suddenly closes with him, such a wound might occur. In the case of the Earl of Essex [*see* illustrative cases], the fact of the wound in the throat being smooth and clean, whilst the blade of the razor lying alongside was very notched and irregular, gave rise to suspicion of murder.

But *a determined suicide may inflict more injuries than one.* Dr. Taylor [p. 501] mentions a case which happened near his house in April, 1872, in which a man stabbed himself with a sort of dagger, and then threw himself from a window forty feet from the ground. The weapon was still sticking in the wound—which, in this case, was in the chest. The Authors know a case in which a lunatic first cut his throat, and, failing thus to kill himself, shot a pistol through his mouth, the bullet entering his brain!

Dr. Guy mentions a case in which an officer nearly severed his head from his body with a razor, but *the razor was found tightly grasped in his hand,* just as in the case of Captain Wright, who was found dead in the Temple, where he had been imprisoned with Sir Sidney Smith. In Wright's case there was a suspicion of murder. But Dr. Guy gives another undoubted case of suicide, in which a madman, after inflicting a severe wound on his throat, had both time and strength to struggle with a maid-servant before he fell down dead. [Guy, *loc. cit.*, pp. 306—7.]

II.—*Injuries of the Chest, involving the Heart and Lungs, and their Coverings, the Large Blood Vessels, &c.*

These wounds will be better understood by a reference to figs. 100 and 101, pp. 763—4. The first figure shows the heart and lungs and great vessels partially divested of the pleuræ and pericardium, and taken out of the chest. The second figure is a transverse section of the chest at the level of the root of the lungs. Fig. 102 shows the valves of the heart. Under the name of chest, or thorax, we include all the parts from the neck to the level of the *diaphragm*, or musculo-membranous partition, between the chest and the belly. The diaphragm is the chief *breathing muscle.* The cavity of the chest, or thorax, is enclosed in a long case formed by the dorsal vertebræ and the ribs and sternum. But the intercostal spaces or intervals between the ribs allow of wounds from knives, daggers, &c., and bullets, and some other weapons, may either wound in the same interstices, or fracture or penetrate the bony coverings. In the chest we have the following important structures:—(1) The *heart*, and the bag it works in, the *pericardium*; (2) the *aorta, and pulmonary artery,* and their branches, and the large veins [superior and inferior vena cava, pulmonary and azygos veins, innominate veins, &c.]; (3) the *trachea and bronchi*; (4) the *œsophagus*, or gullet; (5) the *lungs*, with their pleuræ or coverings;

(6) the *thoracic duct* ; (7) the *pneumogastric and phrenic nerves,* the *anterior and posterior pulmonary plexuses,* and the *splanchnic and cardiac nerves,* &c., &c.

Any of these structures may be wounded by all sorts of instruments. We will first mention the general causes of death in chest wounds. These are (*a*) *hæmorrhage* in wounds of the large vessels, of the heart, and lungs, and even from the *intercostal* arteries ; (*β*) *shock.* This is due either to direct injury to the nerves, or to the reflex action of injuries to important structures ; (*γ*) *inflammation.* Pleurisy, pneumonia, bronchitis, pericarditis, &c., may all result from chest wounds. *Empyœma* is the name given to collections of *pus* in the pleural cavities; (*δ*) *exhaustion* may supervene, on long-continued suppuration, or protracted pain ; (*ε*) *starvation* might possibly result from injuries to the œsophagus or thoracic duct, as it does occasionally from the growth of tumours, &c.

We shall notice first :—

A. *Wounds of the heart.* For obvious reasons, these are most common from wounds on the left side. On the right, and in the middle line, the heart is pretty well covered by lung and by the sternum.

As a rule, *a wound of the heart is fatal,* and generally proves so at once, from the copious hæmorrhage. But Bell [" Principles of Surgery," vol. i., p. 468 ; Guy, *loc. cit.*, p. 308] gives the case of a soldier, wounded by a long and slender sword in the apex of the heart, who lived twelve hours —each beat of the heart had caused a slight bleeding, till the quantity of blood accumulated filled the chest, and stopped his heart and respiration. In a wound of the *coronary* artery, two hours elapsed before death.

But complete recovery may take place ; or in other words, sometimes, though very rarely, wounds of the heart may not prove fatal. In such rare cases, the wound is either inflicted by a small narrow instrument, and the wound closes ; or the missile or weapon does not open the cavities of the heart. In Fournier and Manson's case, a bullet was found imbedded in the heart six years after the man was shot. He died from another cause. In twenty-nine cases of wounds of the cavities of the heart collected by Sanson and Ollivier, only two were fatal within forty-eight hours, the rest in periods varying from four to twenty-eight days. *See* Devergie's " Méd. Légale," vol. ii., p. 253. A number of other references are given by Dr. Taylor, vol. ii., pp. 637-9. *See* "Med. Gazette," vol. ii., p. 721 ; ibid, vol. xiii., p. 662 ; vol. xvii., p. 82 ; and "Annales d'Hygiène," 1846, 1, 212.

The heart may be ruptured without any external wound. (1) From mental emotion, fright, &c., when its walls are very thin and diseased. In this case, it is usually the *left* side of the heart, and particularly the left ventricle (Dr. Hope). *See* Dr. Quain's case [" Med. Gazette," vol. xxxviii., pp. 774 and 857], one by Mr. Marshall [" Lancet," Feb. 16, 1857], and others in the " Transactions of the Pathological Society," and in the medical journals. (2) From accident, when the *right* side of the heart, near the base, generally gives way [" Med. Chir. Review," vol. xxxi., p. 552]. Dr. Gardiner mentions such a case, where a cartwheel passed over a child, and thus caused death. Dr. Taylor gives another. The ribs were not broken. The Authors have seen two such cases. In one there was not even any outward bruise-mark.

Dr. Taylor remarks that it is sufficient for the injury to the heart to involve one of the coronary arteries: it need not open the heart's cavities.

B. *Wounds of the large vessels* (aorta, &c.) are generally from bullets, or from stabs.

Dr. Heil, of Bamberg, reports a case of recovery from wounds of the ascending aorta. (Henke's "Zeitschrift," 1837, bd. 2, p. 459.) The case is, however, rather doubtful; and such wounds are generally considered *mortal*, and rightly so.

C. *The lungs may be wounded by stabs* [with knife, dagger, sword, bayonet, or any sharp instrument], *or by a bullet* (in which case both lungs may be involved), *or by fractured ends of ribs penetrating them.* The dangers are—(1) from hæmorrhage; (2) from shock; (3) from emphysema (see p. 1071); and (4) from inflammation (pleurisy, pneumonia, broncho-pneumonia, &c.), which may terminate in gangrene, or empyæma, or both combined, as pyo-pneumo-thorax, or in prolonged suppuration, with hectic and phthisical symptoms. As in the case of other viscera, the lungs may be *ruptured* from external violence, without any fracture of the ribs, and without any other injury; and sometimes there may be no marks at all on the exterior of the body. Dr. Taylor reports the case of a young man, who fell from his horse on his left arm; for five hours he complained of no pain; after twelve hours blood came from his mouth, and in a few days he died. After death there were no external signs of injury, but the right lung was ruptured posteriorly throughout its length, and much blood had been effused. ["Lancet," November, 1842.] Mr. Jardine reports a similar case in the "Medical' Times and Gazette," Dec. 31, 1853. A lad of fourteen years of age fell 20 feet, and broke his collar-bone, but not his ribs. He died in about three hours. There was no external mark of injury. The right lung was found ruptured to the extent of four inches of its depth. *See* the same Journal for Jan. 19th, 1861; and July 24th, 1851, p. 98. In such cases there is generally bleeding from the mouth; the blood is frothy (*i.e.* mingled with air), very bright or florid in colour; and when there is a wound there is generally cough, as well as hæmoptysis. Air also escapes from this, mixed with frothy blood, if the external opening be large enough. But in many cases—and this is a great source of danger—the blood escapes into the pleural cavity, thus gradually compressing the lung.* The physical signs of this *hæmatothorax* will resemble those of empyæma, or pleuritic effusion. We shall have dead dulness on percussion, which will change its level with position, unless the cavity be quite full, absence of breath and voice sounds,† want of expansion on inspiration, and the heart is pushed over towards the opposite side; so much so, that when this occurs on the left side, the apex of the heart may be seen and felt to beat in the right axilla in some cases; and the patient can only lie comfortably on the side of the effusion. *Secondary hæmorrhage* may occur in some of these cases, particularly in gun-shot wounds. *Hernia of the lung* is sometimes met with; in other words, a part of the lung may protrude through the wound. Mr. Guthrie did not advise returning it, as he thought it acted as a good plug to close the opening into the pleura. It seems, however, more natural to return it, and close the external opening, unless the lung itself is much contused or lacerated. [*See* Guthrie's "Commentaries on Military Surgery," London, 1855; and Dr. Fraser's work on "Penetrating Wounds of the Chest."] *Emphysema* is scarcely dangerous, if properly treated: by this we mean the surgical variety, mentioned at p. 1071. The danger of gun-shot wounds is enormously increased by the presence of foreign bodies, such as portions of the dress, of wadding, splinters of bone, &c. Bits of wood (from floors), and portions of shell, have been met with in wounds from explosive missiles. It should not be forgotten that *wounds of the intercostal arteries* may have the hæmorrhage controlled by passing a wire ligature all round the ribs, by means of a curved needle.

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* The pleuræ, pericardium, peritoneum, and other serous membranes, are shut sacs, which invest the organs to which they belong (lungs, heart, intestines, &c.) like a double nightcap does the head. The space between the *parietal* and visceral layer, or, in the case of the pleuræ, between the lung and the chest-wall, may thus be the seat of effusions, hæmorrhages, &c.

† Except perhaps close to the spine, or at the upper edge of the fluid effused. In this situation there may be altered voice-sounds—Punch like, or squeaking—*ægophonic*, in fact.

Beck records the case of Sergeant Verney, of the 89th Regiment, who at the battle of Niagara Falls received a shot in the breast, about an inch and a half to the right of the sternum, which came out behind, about the same distance from the spine; both lungs were completely perforated, and air escaped from both openings. He did not die, but was freely bled, and in a fortnight was removed to New York, and ultimately made a complete recovery. (Beck, *loc. cit.*, p. 633, note.)

Mr. Maiden, a surgeon practising in Essex, had a case in which a gig-shaft completely transfixed the thorax. The man lived many years after; and the specimen is in the London Hospital Museum. But this blunt body pushed the viscera on one side. In prize-fights, or other combats, the chest may be severely contused. Rupture of the lungs, hæmorrhage, and inflammation or injuries of the heart, may be the result.

In general, *wounds of the lungs must be considered as extremely dangerous, although not uniformly fatal.* In a few cases bullets have been known to lie harmlessly, and, as it were, dormant, in either chest-wall, pleura, or lung, for many years.

D. *Wounds of the diaphragm* must be held to be extremely dangerous. Not only is the diaphragm a principal muscle of respiration, and therefore constantly in motion, but in this injury both the chest and abdomen may be involved. Either pleuræ or pericardia above, with the heart and lungs, or the peritoneum below, with the liver, stomach, spleen, or intestines, or even kidneys, may be involved. Then there is a risk to the large blood-vessels; and, on recovery, there is a risk of what is called *diaphragmatic hernia.*

Such herniæ may contain any of the abdominal viscera, which protrude into the chest. They are most common on the left side. Dr. Gordon Smith ("Forensic Medicine," p. 279) mentions a case in which a man seemed to recover from a wound of the diaphragm from a sharp-pointed weapon; but three months after his stomach got strangulated in this new opening, and he died from this hernia [which receives the name of *phrenic* from some authors]. Dr. A. T. Thompson ["Medical Gazette," vol. xl., p. 584], relates a case of death from strangulated diaphragmatic hernia, containing 14 inches of colon, the original wound in the diaphragm happening a year before from a fall, breaking two ribs. Dr. Taylor (*loc. cit.*, p. 643) gives a case of a man stabbed in a quarrel, who died from this kind of hernia fifteen months afterwards. He refers also to Dr. Reid's "Physiological Researches," p. 521. Devergie [*op. cit.*, vol. ii., p. 250, &c.] draws attention to *ruptures* of the diaphragm from violent blows on the epigastrium, &c., such as kicks. They generally occur during inspiration, this muscle being then on the stretch. He says it is generally the central tendinous portion which is affected, or where it joins the left muscular portion above the crura. The diaphragm, like the muscles, is subject to fatty and brown degeneration, as well as to calcification, and other diseases of muscle. Taylor [*see* Henke's "Zeitschrift" for 1836; and Taylor's work, p. 644] cautions us that *we should pay attention to the obliquity of the ribs in describing wounds of the chest.* This causes a difference of level between the anterior and posterior portions of the ribs. Thus a straight line touching the upper edge of the sixth rib behind, would be on a level with the upper edge of the third rib in front. Thus, in a given case, a pellet of small shot traversed the chest from before backwards, entering between the first and second ribs in front, and traversing the lung, caused death by wounding the intercostal artery of the sixth rib. One medical witness described this wound as *six inches lower* posteriorly than in front. In fact, when allowance was made for the obliquity of the ribs, it was only 1¼ inches lower, as the corresponding spot behind would touch the upper border of the fifth rib. Dr. Taylor says that *Col. Fawcett*, killed in a duel, had a bullet enter the right side of the chest, fracturing his seventh rib, and after traversing the back of the lung, it lodged in the ninth dorsal vertebra, these parts being on the same level. Thus a wound below the sternum, or breast-bone, will involve the abdomen in front, the diaphragm in the middle, and the chest behind.

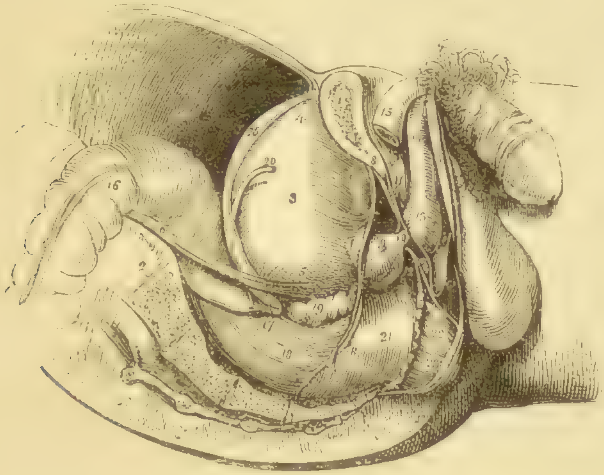
III.—*Wounds of the Abdomen, involving the Stomach, Liver, Spleen, Kidneys, Large and Small Intestines, Pancreas, &c., and Wounds of the Genital Organs and Bladder.*

In these, besides the danger from shock and hæmorrhage, we get the danger of extravasation of blood and urine, or the escape of the contents of the stomach, bowels, and perhaps uterus into the *peritoneal* cavity. The figure at p. 800 (fig. 107), gives a good idea of the reflexions of the peritoneum, of the position of the abdominal organs, and of the uterus in the female. The male *pelvic organs*, and *external* organs of generation, are well shown in the figure subjoined [Fig. 116].

Here—(1) is the *symphysis pubis*; (2) the *promontory* of the *sacrum*; (3) the *bladder*, distended, or full of urine; (4) its summit, or *apex*; (5) is the *trigone* of the bladder, into which (6) the right *ureter* is emptying itself; (7) is the *neck* of the bladder; (8) the *visceral layer of pelvic fascia*; (9) the *prostate gland*; (12) *Cowper's gland*; (13) *bulbous* portion of (14) the *urethra*; (15) the *crus penis*; (16) the *sigmoid* flexure of colon; (17, 18, 21, 22) the *rectum*; (23) the *anus*, with its muscles; (19) the *vesicula seminalis* of right side; (20) *vas deferens*, crossing the bladder to join *vesicula seminalis*, on the inner side of the ureter.

Incised wounds of the abdominal muscles are not more dangerous in themselves than those of other parts; but they may give rise to what is called a *ventral hernia*, by weakening the abdominal wall, particularly if the wound is of any size. This risk surgeons and obstetricians are obliged to run in operations for the relief of intestinal obstruction (rare), in the ligature of the iliac artery, in *ovariotomy*, in the Cæsarean section, and in gastrotomy for uterine fibroids, or for extra-uterine fœtation, &c. &c. The risk can be lessened by the use of a suitable belt, or abdominal bandage. The operations for inguinal and femoral hernia are open to the same objection; only that in these the patient is always told to wear a truss, at least till the parts are consolidated, as in the *radical* cure of hernia [Wood's, Wützer's, Davis's, or other operators' methods]. Both *incised* and *punctured* wounds may be dangerous from hæmorrhage, as when the *epigastric* artery is wounded; still more so, if they penetrate the abdominal cavity, or any of the viscera. *Very slight wounds may prove fatal from inducing peritonitis.*

FIG. 116.



In July 1861 a *Mrs. Cuthrey* died from a penetrating wound caused by a table-knife being thrown at her. The point penetrated about three-quarters of an inch within the abdomen, and the small intestine was slightly perforated. She died of peritonitis. On the other hand, we have known a lunatic cut a gash seven or eight inches long, through which nearly all the intestines protruded. They were replaced, and the wound carefully stitched up. On the second day the wretched man tore open the wound again, but recovered after all, means being taken not only to close the wound, but to prevent his interference. In most of the lower animals the abdomen may be laid open without much risk, provided care be taken to exclude dirt, or blood, or decomposing matters, and the wound be carefully closed again, and the access of air hindered. In the human subject, however, this cannot be done without great risk. Hence surgeons prefer, when possible, to operate on hernia without opening the sac which is formed of *peritoneum*, and to open the *colon* (as in Amussat's operation) where it is not covered by peritoneum. But in Ovariotomy and other operations just named above, this risk must be run. These operations are, however, nearly as fatal as amputations at the hip-joint. In other words about 30 per cent. die. Severe *blows* or *contusions* of the abdomen are often fatal without any external wound;

blows in the epigastrium are especially so. A kick here, or a blow from running against a post, or projecting shaft, &c., has often proved fatal, and sometimes suddenly or instantaneously so. It is supposed that the *solar plexus* or semi-lunar ganglion of the sympathetic is injured in these cases. But other portions of the abdomen have proved equally dangerous when bruised. Such injuries are common in prize-fights, and stand-up fights, pot-house brawls, &c. [*See Taylor*, pp. 645-6, *Watson* on Homicide, p. 75, &c., and the works of Travers, Cooper, &c., "Surgical Dictionary" and Alison; also Beck and Guy, *ad rem.*] In *Rex* v. *Jones*, Warwick Summer Assizes, 1831, a case of alleged manslaughter, the prisoner was charged with having struck deceased several blows on the breast, and one on the pit of the stomach by which he instantly fell down senseless and expired. On dissection no morbid appearances were found. The prisoner was convicted. So in *Regina* v. *Sayers*, C. C. Court, August 1841, a man received a blow in the stomach, and fell dead. The jury thought he must have had apoplexy, and acquitted the prisoner! *See* also *Regina* v. *Laws*, Norwich Lent Assizes, 1854. In these and other cases, the juries seemed to expect that there should be some visible cause of death. But we know that people have expired from simply hearing bad news, and a blow on any portion of the sympathetic nervous system is probably enough to cause death if sudden and severe. Such blows may however, and often do, cause *peritonitis.* In these cases death is less rapid, requiring some hours, and generally a few days to be fatal. Watson records numerous cases in his treatise on "Homicide." Several cases are quoted by Taylor [pp. 646-7]. *See Regina* v. *Martin*, C. C. Court, 1839; *Reg.* v. *Smith*, Manchester Lent Assizes, 1871, and numerous cases in the medical journals of the last thirty years. Sometimes this *peritonitis is accompanied by pleurisy.* At the time when the first case of the kind was noticed, the *communication by means of lymphatics of the diaphragm between the thoracic and abdominal cavities*, now generally admitted by anatomists, was unknown.

Though usually very fatal, *some cases of traumatic peritonitis recover.* Some years ago in France, a young woman fell from a rick on to a hay-knife, which penetrated her vagina, and forced its way into the abdomen. Although she had frightful hæmorrhage, she quite recovered.

Injuries to the abdomen may cause rupture of the solid viscera. Thus the *liver*, *spleen*, and *kidneys* may be ruptured without any external wound or even signs of bruising. A case of this kind, in which the right kidney was torn across, was seen by one of the Authors, and Dr. Finch of St. Mary Church in 1864. *See* p. 1074. Mr. Carter, now of Chelmsford, when house surgeon to the London Hospital, admitted a boy whose liver was ruptured by a waggon wheel going over his abdomen. There were no marks of external injury. Soon after a man who had been kicked in the belly was admitted into the same hospital, and his *spleen* was ruptured.* The Authors have seen several such cases in which the liver was thus torn as it were almost in half—one or two others of injuries to the spleen and kidneys. Dr. Taylor gives a number of such cases [vol. ii., pp. 648-9], Guy and Beck and Casper give others. Indeed it is not now necessary to multiply quotations. Rupture of the liver usually proves fatal in about forty-eight hours or less. But life has been prolonged for several days [eight days in a case known to Dr. Taylor]. Hæmorrhage takes places internally. The result is collapse, coldness of the extremities, hoarse whispering voice, feeble pulse, intense weakness, the abdomen swells up, and is generally very tender and tense. *Consciousness is usually retained.* Dr. Barnes insists much on this fact, as distinguishing *abdominal* collapse from cerebral symptoms. In rupture of the liver or gall bladder, jaundice may set in if the patient lives long enough. In ruptured kidney, blood is found in the urine. Generally speaking, the bladder is filled with almost pure blood, instead of urine. It may be necessary to pass a catheter to prove this. Medical men have been asked how fast the blood would flow into the abdomen from a case of this kind (of ruptured liver, spleen, or kidney, &c.). It is not easy to give a categorical answer, as much will depend on the extent of the rupture, the size of the blood-vessels, the formation of clots, whether the injured person is moved, &c. In some of the recorded cases, the person thus suffering has walked some distance, and this would hasten death. From a few ounces to several pints of blood may be poured out inside the abdomen. Dr. Maclachlan ("Medical Gazette," vol. xxxvii, p. 968) records a case of *ruptured gall-bladder* which happened to an old man from falling out of bed, with great violence on to the floor. He died of peritonitis in forty-eight hours. The gall-bladder was ruptured, and a large gall-stone was found in the cystic duct. The Authors have two or three times known the gall-bladder ruptured by forcible compression in artificial respiration, performed by over-zealous surgeons, to obviate the effects of an over-dose of chloroform. The *stomach and intestines* may be torn, or ruptured by contusions of the abdomen, from blows, kicks, &c., or by wounds with sword, bayonets, daggers, bullets or small shot, &c. To a bullet wound of the stomach in Alexis *St. Martin*, a young Canadian, we owe much of our knowledge of digestion, thanks to Dr. Beaumont's researches. You must remember that in certain diseased conditions (as in ulcers of the stomach, duodenum, ileum, or the large intestine; or softening and degeneration of these organs), death may occur more or less suddenly, from the ulcer bursting into the peritoneum, and thus the contents of the viscus escape into the peritoneal cavity; or the ulceration invades the artery (as in typhoid fever) and death occurs from hæmorrhage. During the cholera epidemic of 1866, some cases of sudden death from this cause were at first erroneously attributed to the collapse of cholera morbus! As St. Martin's case shows, all wounds of the stomach are not fatal. There has, within the last year, been a successful case of gastrostomy or artificial opening into the stomach, to preserve life, which proved successful.* In recent wars, particularly the French-German War of 1870,

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* About a year ago, a Coolie in Ceylon was impertinent, and the plantation superintendent treated him violently—kicking him, &c. He died almost immediately from *rupture of the spleen.* This organ was large and soft. He had had fever a little while before. The abdomen was full of blood. It was attempted to be proved, for the defence, that it was not uncommon for the spleen to rupture

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spontaneously in Coolies when thus diseased; and Dr. Norman Cheevers was quoted as an authority in proof. The Chief Justice said that, even if diseased, there could be little doubt that the violence (which was not denied) must have *accelerated* the rupture. The superintendent was therefore condemned to eighteen months' imprisonment with hard labour.

* This operation is indicated when the œsophagus or pharynx is blocked by cancerous growths, or other strictures, so that food cannot reach the stomach, or only in insufficient quantities. It has, in general, been deferred until life was almost extinct, to the discredit of the operator.

there were several cases of recovery from bullet wounds with fistulous openings into either the large or small intestine. *Simon* published several such cases in the "Berliner Klinische Wochenzeit." Most writers on injury to the stomach agree that rupture of the stomach is most likely to occur, and most fatal, when the stomach is full. The risk of peritonitis, from decomposing food in the peritoneal cavity, is of course increased in the case of a full stomach. *Beck*, loc. cit., p. 636, records a great diversity of medical opinion in past times, as to the fatality of wounds of the stomach, &c. Most modern surgeons are agreed that though generally fatal such injuries are not necessarily so, this being proved by numerous examples. *See* "North American Medical and Surgical Journal," vol. ii. p. 199. Mr. Breton in "Transactions of the Medical and Physical Society of Calcutta," vol. i., p. 59. Sir Astley Cooper's Lectures, vol. iii., p. 155, Dr. Beatty in "Cyclopædia of Pract. Med.," art. "Death from wounds," vol. iv., p. 556. [Numerous references are also given by Taylor, loc. cit. pp. 653-6].

N.B. The *stomach*, though sometimes popularly used to signify the belly or abdomen, means, in medical language, the bag in which the food goes when swallowed, and where the albuminous or nitrogenous food is chiefly digested. It has a *cardiac* or œsophageal end, a greater and lesser curvature, and a *pyloric* end or *pylorus*, a frequent seat of cancerous stricture; the *small* intestine is divided into the *duodenum*, the eight to ten inches next to stomach, the *jejunum*, $\frac{2}{5}$ths of the remaining small intestine; the *ileum*, the remaining $\frac{3}{5}$ths; the large intestine is divided into the *cæcum*, ascending, transverse and descending *colon, sigmoid flexure* and *rectum* or straight gut, terminating at the *anus.*

The *pancreas and thoracic duct* have once now and then been wounded, generally by bullets. The *abdominal aorta, vena cava*, and the *iliac* and other abdominal arteries, have over and over again been wounded by stabs and bullet wounds leading to fatal hæmorrhage, or rarely, to slower death by peritonitis.

Wounds of the bladder are generally, though not invariably, fatal. This is due to a fatal form of peritonitis, with sloughing and gangrene induced by the extravasated urine. *Life may sometimes be saved by free incisions in the perinæum.* The bladder may rupture spontaneously in cases of retention of urine, from calculi or from stricture of the urethra. But if a man, previously in good health, gets a blow on the lower part of the abdomen, when his bladder is full, there can be little doubt that his speedy death is due to the accident. Very strong evidence of previous disease would be necessary to shake such a conclusion. Careless midwives or accoucheurs sometimes allow a woman's bladder to get distended in parturition, and thus the child's head may burst it. Some have been fools enough to put on the forceps or use other instruments without first ascertaining the condition of the bladder! A retroverted gravid uterus may lead to this accident of rupture of the bladder. But the majority of cases are traumatic, due to kicks, violent blows, or gunshot wounds. The cases from bullets are said to live longer than those produced in other ways. Dr. Taylor records twenty days in one fatal case of this kind. Mr. Byron Blewitt informs me that the tension of the abdomen, which was induced by a full bladder, was enough in many cases to cause bullets (probably nearly spent) to deflect their course, and go around the abdominal wall to the opposite side, without perforating the abdomen. Many of the soldiers in the Franco-

German War of 1870, to which he refers, fired from the hip [such were the orders], to avoid the danger to sight from the imperfect closure of the breech-blocks of the guns. The recoil or escape of powder, &c., from the breech was the cause of injuries to the lower part of the abdomen and to the bladder, hip, &c. In *Regina* v. *Eccles* [Lancaster Lent Assizes, 1836], the judge has been, as we think, misunderstood to have alluded to a *full-bladder* as if it were an extenuating circumstance. Dr. Taylor remarks that it is as natural to the bladder to be sometimes full, as it is to the uterus to be sometimes gravid, and indeed more so. Yet pregnancy would not be regarded as an extenuating circumstance, if a man kicked a woman with child to death. For numerous cases of rupture of the bladder by external violence, *see* the "North American Medical and Surgical Journal," vol. v., p. 231; and the "Edinburgh Medical and Surgical Journal," vol. xxx., p. 86; and the "American Journal of Medical Sciences," vol. xii., p. 535. Other references will be found in *Taylor* [*loc. cit.* p. 657], and numerous cases in the medical journals for the last thirty years. *See* also Watson on "Homicide." Dr. Taylor remarks that the bladder may be ruptured by an accidental fall, and quotes a case from Mr. Syme of a woman falling over a tub. ["Edinburgh Medical and Surgical Journal," October, 1836], and two in drunken sailors from Mr. Spencer Wells' reports ["Medical Gazette," vol. xxxvi., p. 621]. Incontinence of urine may be the result of injury to the neck of the bladder.

Wounds of the genital organs may be accidental, self-inflicted, or purposely done by others. They may be produced by blows, kicks, cutting weapons, stabs, or bullet wounds. They are dangerous (1) from *hæmorrhage* in both sexes, particularly in females; (2) from shock; (3) from the after consequences—such as erysipelas, pyæmia, &c.

But besides the danger of death or protracted suffering, there is the further danger of impotence and sterility in the male sex, and of sterility in the female. *These wounds may be self-inflicted in some cases.* Take the following from "Lloyd's News," of Sept. 12th, 1875. "Early on Wednesday morning a foreman boiler-maker employed at Messrs. Laird's Works, Birkenhead, went home after drinking to a considerable extent in a public-house. Some words passed between his wife and himself in the bed-room, and the man, exclaiming 'You'll repent this as long as you live,' went to a drawer and took out a razor, with which he inflicted a shocking wound upon his abdomen, a large portion being almost entirely cut away. He was conveyed to the Borough Hospital in a cab." In this case, the man amputated both the penis and scrotum, with both testicles. In a similar case reported in the "British Medical Journal" of Feb. 5, 1870, by Messrs. Francis and Grant, Surgeons of Market Harborough, the patient cut off the penis, most of the scrotum and both testicles with a blunt rusty pair of scissors. He ate one testicle! He had been suffering from *delirium tremens*, had been worried by arguments against Romanism, and was separated from his wife. In a similar case, which was admitted to the London Hospital, a similar extensive mutilation was done by a Jew to himself, with a blunt table-knife. This patient, like the one above, ate both testicles! In his case there was delirium tremens, and there had been arguments about religion. Other cases are on record in which either the wife, or some other female, generally a paramour, has inflicted this mutilation from jealousy or from revenge. In these cases the man has generally been either dead drunk, or has been first bound to a bedstead or otherwise prevented from struggling. The bluntness of the weapon has often prevented a fatal result. But the dorsal artery of the penis, and the spermatic arteries usually require ligatures. We need scarcely say that total impotence and sterility must be the result. Occasionally one testicle escapes by retraction within the inguinal canal. In the case of females, murderers sometimes seem to think that the injury will be ascribed to natural causes, such as menstruation, or flooding from the uterus. Beck quotes from Mr. Watson [" Edinburgh Medical and Surgical Journal," vol. xxxvi., p. 85] two cases of such injuries, in which the murderers were the first to call for assistance, no doubt for this reason. In both the *labia pudendi* [greater and lesser lips of the vulva, *see* p. 729] had been incised with a cutting instrument, either a knife or a razor. Death followed in each after a few hours. The murderer was convicted in one case, and only escaped in the other, because the medical witnesses stated that it was *possible, though very improbable*, that the wound might have been inflicted by falling on glass or a sharp body. As the wound was not lacerated, or penetrating, or contused, it is clear that the female must have sat down on a sharp piece of glass when standing erect, and her clothes must have been out of the way, as they were not cut. All this too must have happened on a pair of stairs ! [*Beck:* note to p. 642, *see ibid.* p. 641 for the following case.] Dunlop states that a medical friend of his was called to see the wife of a sergeant, who had received a stab in the side, with a knife, wounding the *uterus.* She was then eight months pregnant.* To screen her husband she said she had fallen on top of a knife, *but the direction of the wound was from above downwards.* She afterwards told some woman of the regiment that her husband inflicted the wound. It was known that they lived unhappily together. She died ; but the husband was only convicted of manslaughter, partly because the doctor said the wound was not necessarily mortal, and partly because the jury could not agree to the severer verdict. Such *wounds to the gravid uterus are generally mortal,*† because peritonitis is set up, even if the sufferer recover from the first hæmorrhage. Dr. Taylor gives the case of a child, aged six years, who fell, with legs wide apart, from a tree she had climbed, on to one of the sharp shoots of the tree below ; the wood, about ½ an inch thick, entered her vagina, and passing through its posterior wall, broke off. A woman removed the stick with some difficulty. In twenty-eight hours she died from peritonitis. ["Lancet," 1871, vol. ii., p. 74.] *Kicks on the female genitals* will sometimes cause profuse hæmorrhage. One of the Authors saw a policeman give a woman two severe kicks from behind. He insisted on the woman, who bled profusely, being taken to St. Mary's Hospital; but she died within two days. Mr. Gutteridge [*see* "Lancet," Oct. 31, 1846, p. 478] saw a woman who had been kicked by her husband, whilst stooping, and lost three or four pints of blood. She died in about an hour. There was a wound at the edge of the vulva, extending from the bubes along the ramus of that bone, about 1 inch long, and $\frac{3}{4}$ of an inch deep. The left *crus clitoridis* was completely crushed, and from this the bleeding had proceeded. The heart and large vessels were bloodless.

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* During the later months of pregnancy the uterus is in the abdominal cavity. It rises out of the pelvis between the third and fourth months. *See* page 691 for an account of its positions.

† Dr. McClintock (" Medical Times," May 15, 1847) reports a case of recovery from a contused wound in the genitals, with a laceration, in a pregnant woman. Recovery is, however, very rare.

It is sometimes said that *the injuries were inflicted after death.* In such a case there would be far less hæmorrhage, and other characters of wounds inflicted in life would be wanting. [*See* p. 1075, *et seq.*] Falling on fragments of broken pottery, the horn of a goat [*see* p. 734], sharp stakes, crinoline-steels, &c., have all been known to inflict *accidental wounds on the female genitals.* In general there will be circumstantial evidence to prove this. Such wounds are generally lacerated and penetrating. [*See* Watson on "Homicide," Beck, Guy, Taylor, Casper, Devergie, &c., and the following special references; "Dublin Quarterly Journal," 1870; *Regina* v. *Ling*, reported in the "Lancet," 1870, vol. ii., p. 268. In this case blood and hair were found on a stick, which corresponded to the wound. Yet one medical witness attributed the death to the bursting of a varicose vein! "Lancet," 1871, vol. ii., p. 74, "On Wounds of the Male Genitals;" "Annales d'Hygiène," 1868, 2, 110, by Toulmouche; ibid., 1848, 1, 443; and 1865, 1, 156; "Medical Gazette," vol. xliv., p. 813; case of *Regina* v. *Cawley*, Liverpool Winter Assizes, 1847; "Association Medical Journal," by Mr. Barrett, June 28, 1856, p. 538.]

Though rarely, death happens now and then from *circumcision.* The Authors know of one or two cases in Hebrew children; and of two others in cases done for surgical reasons in young infants. These children died from neglected hæmorrhage. Dr. Schwartz, of Vienna, reported two others in infants, eight days old (also Hebrews), one of whom died five days, the other twenty-five days after the operation, both of phlegmonous inflammation. Such cases are probably not met with more than once in about 4,000 or 5,000 cases. Remember that besides ordinary lunacy, there may be injury inflicted on the genitals from misinterpretation of Scripture, or in religious frenzy. Origen castrated himself for the former reason. The *Skoptsi*, a Russian sect, entirely mutilate both sexes. No surgeon is justified in performing *castration* for masturbation or epilepsy, or for any other reason, except incurable disease of the testicles or scrotum (such as cancer), because it has been abundantly proved that the sexual appetite is not destroyed by this operation; as Terence says of eunuchs:—

> "At pol ego amatores mulierum esse audieram eos maxumos,
> Sed nihil potesse."—*Eunuchus*, Act IV., Sc. 3.

IV. Injuries to the extremities (the arms and legs) may be dangerous to life—(1) From hæmorrhage; (2) From tetanus; (3) From erysipelas, gangrene, and other untoward sequelæ, such as pyæmia, and hectic fever, when joints or bones are involved; (4) From shock. But apart from danger to life, there is the permanent damage which may accrue, whereby either the man or woman's enjoyment of life, or their means of procuring a livelihood, are destroyed or impaired. Incised or lacerated wounds may cause fatal hæmorrhage, or *tetanus** may supervene, or syphilis, struma, or previous disease of any kind may cause the wound to ulcerate, slough, or suppurate profusely; or erysipelas may set in. An interesting case of this kind came before the Justiciary Court, in the Autumn Circuit, at Glasgow, in the year 1822. A man, named *Pace*, gamekeeper to Lord Blantyre, was tried for the murder of a poacher, whom he shot so severely in the left *arm*, that it was found necessary to amputate it above the elbow. The man died of phlegmonous erysipelas in the right leg; and the question on the trial was whether the erysipelas was brought on by the wound or not. On this the medical men differed. Mr. John Burns, the most eminent surgeon in Glasgow, gave it as his opinion, that the debility caused by the wound brought on the disease of which he died. Dr. John Thompson of Edinburgh was of opinion that it was brought on long before he received the wound. It appeared that he had been out poaching for two nights, and had slept without shelter; that he had then eaten very little, and that he also had a foul ulcer in the leg. It was therefore argued that the antiphlogistic treatment he received in consequence of the wound was the best thing possible for the leg. The jury acquitted the gamekeeper. Now-a-days many, perhaps most surgeons, would adopt a stimulant treatment in this kind of erysipelas! [*See* Beck, note to p. 643. The case is taken from Dunlop.]

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* Dunlop states that a wound of the adductor muscle of the thumb (that muscle which lies in the palm of the hand) more frequently brings on lock-jaw than an injury of equal extent anywhere else.

Beck also gives the following case from the "Edinburgh Annual Register," vol. vi., part ii., p. 121:—"*J. Denton* was indicted in September, 1813, at the Old Bailey, for the murder of C. Denton. He had struck her with a knife, and she lived a month thereafter. The medical testimony stated that the wound had nearly divided the arteries of the arm. *It mortified, and she died in consequence.* He was condemned, and executed." *Gangrene* or mortification is most likely to occur when the arteries are degenerated or diseased. [*See* pp. 1057 and 1064.] Wounds at or near joints, wounds involving the periosteum of long bones, and those in which there is a great destruction of skin, and bruising, and laceration of the soft tissues, are the most likely to be dangerous.

Compound fractures and *dislocations* are of course more dangerous than simple ones; and if two or more limbs or joints are involved, the danger is proportionately heightened. Again, the nearer the injury (fracture or wound, &c.) is to the trunk, the greater the danger in general. On these points, and on the question of the surgical treatment of such cases, *see* the chapter on Malapraxis, pp. 712—724.

As regards any particular *method of treatment* in a given case, we hold strongly that it is not necessary, in order to constitute proper and skilful treatment, that the plans adopted should be *fashionable.* But it is right and proper that the given treatment should be—(1) Either such as has been generally recognized by the medical profession [such as the use of opiates to relieve pain, the amputation of a hopelessly damaged limb, the use of mercury in syphilis, &c.]; or (2) That it should have been recommended by eminent authorities, *e. g.* the use of chloroform in obstetric practice, by Sir James Simpson; trephining in injuries of the head (Astley Cooper, Guthrie, Hutchinson); or (3) That it should in itself be reasonable, and founded upon some well-known, or generally admitted facts, or natural laws: for instance, Hunter's operation for aneurisms; the ligature of arteries for hæmorrhage, &c., long before they became popular, were thus *reasonable;* or (4)

Though the *modus operandi* of the treatment may not be susceptible of a patent or easy explanation, yet it may admit of numerous proofs of its efficacy, *e. g.* the use of *quinine* for *ague*, or of *iodide of potassium* for *syphilitic fever*, would come under this category.

The entry of air into veins, though more common in the neck, in operations on that region, might possibly cause death in operations on the limbs. The frothing of the blood thus induced stops the circulation in the lungs. Air is said in these cases to enter with a hissing noise, and death happens almost immediately. Some of the recorded cases were probably due to *syncope*. But it is certain that animals can be killed in this way. Dr. Willis, of Barnes, met with this accident in introducing a seton into the neck. A small vein only was punctured—not the jugulars—which have generally been implicated. [On this subject, *see* Erichsen's "Principles and Practice of Surgery," p. 185; Holme's "System of Surgery," *ad rem.*; and Taylor, *loc. cit.*, p. 641, who refers to the following cases and authorities:—"Medical Gazette," vol. xli., p. 608; *ibid.*, vol. xliii., p. 1098; *ibid.*, vol. xlv., p. 926, an article by Mr. Lane; Claude Bernard's "Leçons," p. 163; Fergusson's "Surgery," p. 444; and the "Association Journal," Jan. 28, 1853, p. 91.]

Remember that bones may be broken by *muscular action only*. The patella often is so. We have now given you so many cases, and references in the text, on the subject of gun-shot and other wounds, that it will only be necessary to give a few additional

Illustrative Cases.

Case I.—*The Alleged Suicide of the Ex-Sultan Abdul Aziz.*

[This event happened in June, 1876. (*See* "British Medical Journal" for June 10, and June 17, 1876; and the daily Journals, *passim.*]

The Medical Report, signed by nineteen physicians, states, that they "found the body lying on a mattress, placed on the floor. The body was covered with a new sheet. Having removed this covering, we recognized ex-Sultan Abdul Aziz. All the parts of the body were cold and bloodless, pallid, and covered with coagulated blood. There was no post-mortem rigidity. There were limpid streaks of blood upon the arms and legs. A little below the bend of the left arm a solution of continuity was found, 5 centimètres in depth [= 2 inches]. The edges of this wound were slashed and irregular; the direction of the wound was from above, and from within the veins of this region were cut; the cubital [*i. e.* radial] artery, close to the point of emergence, was open for $\frac{3}{4}$ths of its diameter. At the bend of the right arm we found a slightly oblique wound, also slashed, to the extent of 2 centimètres ($\frac{8}{10}$ of an inch), and $1\frac{1}{2}$ centimètres ($\frac{6}{10}$ of an inch) in depth. On this side we found a lesion only of the small veins; the arteries were intact. We were shown a pair of scissors, 10 centimètres (4 inches) in length, very sharp, and of which one of the blades had a small lateral knob near the extremity. These scissors were stained with blood; and we were told that it was with the aid of this instrument that the ex-sultan had inflicted upon himself the wounds above described. From what precedes, we are unanimously of opinion—(1) That the death of the ex-sultan was occasioned by hæmorrhage from the vessels of the bend of the arms; (2) That the instrument (the scissors) shown us might precisely produce those wounds; (3) The direction and the nature of the wounds, as well as the instrument which was said to have produced them, caused us to come to the conclusion that the case is one of suicide." [Here follow the signatures.] The medical press in England, France, Germany, and America, regarded this case with grave suspicions, as one of possible murder. For—(1) There was no internal post-mortem examination; (2) The description of the wounds, &c., is a loose one; (3) There is no account of the quantity of blood lost; (4) The body had been moved and undressed before the doctors were summoned at all. Death from the cause named would probably take some time. The Authors have known a lad walk nearly half a mile after similar injuries to those described; (5) No attempt seems to have been made to stop the bleeding; (6) No account is given of the state of the room; (7) The large number of medical signatures to so loose a document was itself suspicious; (8) The body was very hurriedly buried; (9) There is nothing in the direction of the wounds or in their nature to prove them suicidal. A suicide would more likely cut his throat, or open the femoral artery, or stab himself in the heart, &c. On the other hand, Dr. Dickenson alleges—(1) That the ex-sultan was in a state of melancholia, and addicted to drink; and (as we know) the affairs of Turkey were going badly; he had just been deposed from the throne, and was in fear of torture, or a disgraceful death; (2) The scissors were always carried by him (for trimming his beard?). On the other hand, it is said by some that they were embroidery scissors, lent him by his mother; (3) There was blood enough lost to account for death; (4) He locked himself in, therefore no help could be given him.

Reviewing the case, without any bias one way or the other, we cannot but think the circumstances of the case strongly suggestive of assassination, rather than suicide. Both in Turkey and Russia violent methods of getting rid of unpopular sovereigns still remain in vogue—methods which England has abandoned since the death of King Charles I., and France since that of Louis XVI.

CASE II.—*Attempted Murder of the Duke of Cumberland, and Suicide of his Valet, Sellis.*

[*See* Beck, p. 540, who refers to the "Edinburgh Annual Register," vol. vi., part ii., p. 19; Gordon Smith's work, p. 284; Paris "Med. Jurisprudence," vol. iii. p. xxxii; London "Atlas" newspaper, June 24, 1832.]

In 1813 some excitement was caused in England by the sudden death of *Sellis*, a servant of the Duke of Cumberland, and the simultaneous injury received by his Royal Highness. Sir Everard Home says:—"I visited the Duke, and found my way from the great hall to his apartment by the traces of blood which were left on the passages and staircase. I found him on the bed, still bleeding, his shirt deluged with blood, and the coloured drapery above the pillows *sprinkled* with blood from a wounded artery, which put on an appearance which cannot be mistaken by those who have seen it.* This could not have happened had not the head been lying on the pillow when wounded. The night-riband, which was wadded, the cap, scalp, and skull, were obliquely divided, so that the pulsations of the arteries of the brain could be distinguished. While dressing these wounds a report came that *Sellis* was dead. I went to his apartment, found the body lying on its side on the bed, without his coat and neckcloth, the throat cut so effectually that he could not have survived a minute or two. The length and direction of the wound was such as left no doubt of its being given by his own hand; *any struggle would have made it irregular.*[*] He had not even changed his position; his hands lay as they do in a person who has fainted; they had no marks of violence upon them; his coat hung upon a chair, out of reach of blood, from the bed; the sleeve, from the wrist to the shoulder, *was sprinkled with blood, quite dry, evidently from a wounded artery,*[†] and from such kind of sprinkling the arm of the assassin of the Duke of Cumberland could not escape." [Wills' "Circumstantial Evidence," p. 89.] Whilst disputing some of the grounds on which Sir Everard Home's opinion was grounded we do not dispute his conclusions, for a careful review of the whole case leads to the same conclusion.

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* Muscular movements sometimes cause venous blood to escape in jets from a wounded vein.

CASE III.—*Murder or Suicide of Arthur, Earl of Essex, in* 1683.

[*See* Beck, p. 540-2, who refers to the "The trial of L. Braddon," in Hargreave's "State Trials," vol. iii., p. 855; Braddon's pamphlet, "The Earl of Essex's innocence and honour Vindicated," *ibid*, vol. iii., p. 899-934; "The Republic of Letters" for August, 1735; "Bp. Burnet," vol. ii., p. 212-234; "Gordon Smith" (*loc. cit.*, pp. 282-3); Howell's "State Trials," vol. ix., p. 1229; Hallam's "Constitutional History," &c.]

We quote Beck with a few verbal changes.

"Arthur, Earl of Essex, was committed to the Tower on the 10th July, 1683, during the reign of Charles II., when James, his brother (then Duke of York), was supposed to have great influence in the Government. On the 13th (the day of Lord William Russell's conviction and sentence), the Earl was found dead in his chamber, with his throat cut. Before the coroner's jury saw it the Earl's body was taken out of the closet, and stripped of its clothes; they were carried away, and the closet washed, and when one of the jury insisted on seeing his clothes, the coroner was sent for into another room, and upon his return told the jury *it was my Lord's body, and not his clothes, they were to sit upon!* Two surgeons, Sherwood and Andrews, deposed as to the wound. *Sherwood* said, 'the trachea (or as he phrased it, the *arteria aspera*, an old name for the windpipe) and the gullet, with the jugular arteries (*sic*) were all divided.' *Andrews*: 'that the throat was cut from one jugular to the other, and through the windpipe and gullet into the vertebræ of the neck, both jugular veins being divided.' The verdict of the coroner's jury was, 'That with a razor the Earl of Essex gave himself one mortal wound, cut from one jugular to the other, and by the *aspera arteria* and windpipe (*sic*) to the vertebres of the neck, both the jugulars being thoroughly divided ; and of this he died.'"

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[*] We have objected to this *dictum* of Sir E. Home's at page 1141. Many suicidal wounds of the throat are very *ir*regular, and some homicidal ones quite regular.

[†] Be sure that the blood-stains by which you seek to identify a prisoner are at least *like* human blood. In one case in which one of the authors was consulted, the blood-stains on a man's sleeve were camel's blood, possessing oval corpuscles. [See Chapter on Blood-Stains.] He was employed at Jamrach's Menagerie. A camel bit him, and he struck the camel's mouth. In another case, a poulterer's wife had blood-stains from a common domestic fowl, which were at first supposed to be human blood.

One Lawrence Braddon soon after formed the opinion that this was a murder, accomplished by individuals who were allowed to pass by the Earl's keepers. These murderers, he supposed, were set on by the Duke of York, afterwards James II. He was tried for a misdemeanour in suborning witnesses to prove this, and fined £2000. After the revolution, in 1690, he published the pamphlet named above. The closet was, he says, about 3 feet 2 inches wide, and there was no blood higher than the floor. The instrument was a French razor, 4¼ inches in its blade ; and had no spile or tongue at the end. Hence it must have been held by the blade, and it would seem difficult to inflict so large a wound with it. A surgeon is said to have suggested to the jury that *the notches in the razor were made by my Lord against his neck bones* (vertebræ).* Lord Essex was *right-handed*, and the razor lay on his *left* side. Two witnesses swore that the neck of his cravat was cut in three pieces, and there were five cuts on his right hand. Bishop Burnet, who believed the case to be one of suicide, affirmed that the trachea was not cut ! Some physicians and surgeons affirmed that a suicide could not cut so deep, or so desperately as to cut his own vertebræ ! In this we know they were wrong, as numerous cases besides that in the note, prove that suicides have often done this. The Committee of the Lords, who took this evidence, made no report ? Hume and Hallam ascribe it to suicide, the first because the Earl was subject to fits of deep melancholy, and accustomed to defend the lawfulness of suicide ; the latter because he will not think the king and his brother could be guilty of a crime from which they had nothing to gain. Careful readers of the above account will see several suspicious circumstances. Chaussier quotes two cases from Ambrose Paré, one of an Englishman robbed and wounded with a dagger, and left for dead, at Vincennes. He was found in his shirt, with the trachea and œsophagus completely divided. Paré brought the wounded parts together, so that he was able to speak ; he named his murderers, who were taken and executed, and he died three days after. In the other case a maniac, in the night, in his own room, cut his throat in the same way, besides stabbing himself in several places. He was found thus in the morning, and his servant arrested on suspicion. He also was so far recovered as to be able to confess that he had done it himself.

In another case quoted by Beck (p. 543) *some bloody footprints, which aroused suspicion in a suicidal case, were proved to have been made by an aged physician stepping into the blood !*

Beck, Taylor, Devergie, and Foderé give numerous cases of cut throats. We will quote one more from the former.

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* A table-knife used by a suicide who inflicted almost similar injuries on herself, was so notched. She had cut against two or three vertebræ. One of the authors attended this case, and heard her confess it.

CASE IV.—*The Murder of Jane Norkott, in Hertfordshire, from the Notes of Sir John Maynard, an eminent English lawyer. It is stated by him to have happened in the Fourth Year of King Charles I. The Body Bleeds after Death.*

[Beck, *loc. cit.*, p. 543, &c.; Hargreave's "State Trials," vol. x. Appendix No. 2, p. xxix.]

"Jane Norkott was found dead in her bed, her throat cut, and the knife sticking in the floor. Two females and a man slept in the adjoining room, and they deposed that the night before she went to bed with her child, her husband being absent, and that no person after that came into the house. The coroner's jury gave a verdict of *felo-de-se* [suicide]. But a suspicion being excited against these individuals, the jury desired that the body might be taken up (their verdict not being yet drawn up in form), and accordingly, *thirty days* after her death, she was taken up, and the jury charged them with the murder. They were tried at the Hertford Assizes, and acquitted, but so much against evidence that Judge Hervey let fall his opinion, that it were better an appeal were brought, than so foul a murder should escape unpunished. Accordingly an appeal was made by the child against *his father, grandmother, and her husband, Okeman.* The evidence adduced was, that "she lay in a composed manner in her bed, the bed-clothes not at all disturbed,* and her child by her in bed. Her throat was cut from ear to ear, and her neck broken. There was no blood in the bed, saving a tincture of blood on the bolster whereon her head lay, but no substance of blood at all. From the bed's head there was a stream of blood on the floor, which ran along till it ponded in the bendings of the floor. It was a very great quantity; and there was also another stream of blood at the bed's foot, which ponded also on the floor to a very great quantity, but no continuance or communication of blood of either of these two places from one to the other, neither upon the bed, so that she bled in two several places; and it was deposed, that on turning up the mat of the bed, there were clots of congealed blood in the straw of the mat underneath. The bloody knife was found in the morning, sticking in the floor, a good distance from the bed; but the point of the knife, as it stuck, was towards the bed, and the haft from the bed. *Lastly, there was the print of a thumb and four fingers of a left hand.*

"*Sir Nicholas Hyde*, Chief Justice. 'How can you know the print of a right hand from that of the left in such a case?'

"*Witness.* 'My Lord, it is hard to describe; but if it please the honourable judge to put his left hand upon your left hand you cannot possibly place your right hand in the same posture,' which being done, and appearing so, the defendants had time to make their defence, but gave no evidence to any purpose."

The jury brought in all guilty except Okeman, and they were executed, but made no confession. Another remarkable event is detailed by Sir John Maynard, who says:—"An ancient and grave person, *being minister to the parish where the fact was committed*, being sworn to give evidence, according to custom, deposed, That the body being taken up out of the grave, thirty days after the party's death, and lying on the grass; and the four defendants being present, were required each of them to touch the dead body. Okeman's wife fell upon her knees, and prayed God to show tokens of her innocency. The appellant did touch the dead body, whereupon the brow of the dead, which before was of a livid and carrion colour (in terminis, *the verbal expression of the witness*), began to have a dew or gentle sweat arise on it, which increased by degrees till the sweat ran down in drops on the face; the brow turned to a lively and fresh colour; and the deceased opened one of her eyes. and shut it again, and this opening of the eye was done three several times. She likewise thrust out the ring or marriage finger three times, and pulled it in again; and the finger dropped blood from it on the grass. *Sir Nicholas Hyde*, Chief Justice, seeming to doubt the evidence, asked the witness, 'Who saw this besides you?' *Witness.* 'I cannot swear what others saw; but, my Lord (said he) I do believe the whole company saw it, and if it had been thought a doubt, proof would have been made of it, and many would have attested with me.' Then the witness, remarking some admiration in the auditors, spake further: 'My Lord, I am minister of the parish, and have known all the parties, but never had any occasion of displeasure against any of them, nor had to do with them nor they with me; but as I was minister the thing was wonderful to me; but I have no interest in the matter, but as I am called upon to testify the truth, and this I have done.' [This witness was a very reverend person, as I guessed, of about seventy years of age. His testimony was delivered gravely and temperately, to the great admiration of the auditory.] Whereupon, applying himself to the chief-justice, he said:—'My Lord, my brother here present is minister of the next parish adjacent, and, I am sure, saw all done that I have affirmed.' Therefore that person was sworn to give evidence, and did depose in every point 'the sweating of the brow, the change of the colour, thrice opening the eye, the thrice motion of the finger, and drawing it in again.' Only the first witness added, that he himself dropped his fingers in the blood which came from the dead body, to examine it, and he swore he believed it was blood."

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* *See* a similar case, related by Dr. Swinburne of Albany, U.S., where the bed-clothes were equally smooth, and blood continued to ooze for twenty-four hours after death. Taylor (*loc. cit.*), vol. ii., p. 520.

In the trial of Stansfield, for the murder of his father, (says Beck) a similar charge was brought. It is stated that when the son was assisting in lifting the body of his father into the coffin it bled afresh, and defiled all his hand. [Hargrave, vol. iv., p. 283.] The opposite lawyers, assigned as a cause of the bleeding that the surgeon made an incision about the neck, and the motion of the body in removing it caused the fresh hæmorrhage from the neck. The New England Pilgrims firmly believed in this bleeding of dead bodies, as they did in witches. [Thatcher's "Indian Biography," vol. i., p. 158. *See* Metzger, p. 328, and Valentine's "Novellæ," App. 3. De stillicidio sanguinis in hominis violenter occisi cadavere conspicui, an sit sufficiens præsentis homicidæ indicium?"]

[Whilst we may freely admit that the movements of the eye and finger were *imagined*, and that in some of these cases, red fungi, or water impregnated with iron, may have been mistaken for blood, yet the number of such recorded cases, and some modern instances, force us to conclude that a blood-stained fluid [probably a solution of blood colouring] may flow from a dead body a long while after death, or even after burial. *See* note to p. 1072. In any case which may hereafter occur it is much to be wished that the supposed blood should be examined chemically, microscopically, and by the spectroscope.—Authors.]

CASE V.—*Rupture of an Aneurism; Death Supposed to be due to Violence.*

[This case was given us by Dr. Corfe, from the records of the Middlesex Hospital.]

Jane S———, a married woman, aged twenty-eight years, plethoric and intemperate, was violently struck by her husband six weeks before her death. Three weeks after the blow she had hæmoptysis, and finally died from a fatal bleeding in the street. The coroner's inquest brought in a verdict of manslaughter against the husband. Death was proved to have resulted from the bursting of an aneurism of the aorta, the size of a pullet's egg, in the descending part of the arch, just about the bifurcation of the bronchi. It burst into the left pleura. The medical witness deposing that aneurism was generally due to atheroma, the bench stopped the case, remarking, " If previous disease is sworn to I must stop the case." The man was therefore acquitted. This law, however, is inconsistent with repeated decisions of our judges. *See* p. 1060, where the dictum of Lord Hale is quoted.

CASE VI. *The Attempted Murders at Drayton. Shooting with Intent to Murder.*

[From the " Oxford Journal," Jan. 13, 1877.]

" At the County Bench on Monday last Benjamin Marshall was brought up on remand, charged with shooting at, with intent to murder, James Beesley and Elizabeth Beesley at Drayton, on the 30th December, 1876. James Beesley deposed that the prisoner had been courting his daughter Elizabeth. She broke it off about Christmas. The prisoner made his appearance again first the day after Christmas Day; his daughter told him she would have nothing more to do with him, and went out of his way. On Wednesday and Thursday he called again, and there was further conversation on the same subject. On Friday evening he wanted her to have a drop of drink. On the Saturday he shot at both father and daughter. The surgeon, Mr. Slade Innes Baker, deposed that on going to the house, he found Miss Beesley very faint, sitting on the sofa, supported by two women. ' There was blood on the outer garment, and a small hole in it, such as would be produced by a bullet passing through it. I found a corresponding hole in the inner garment. After taking off her clothes I found between the eighth and ninth ribs a small opening, which was bleeding a little. I probed the wound, and found it passed in about one and a half inches downwards and outwards. I could not detect any bullet. I think the bullet is somewhere in her body. She is at present making satisfactory progress. The bullet could not have come out. I afterwards examined Mr. Beesley. I found in his trousers on the right groin a mark of singeing, and a small hole, such as would be made by a bullet, and a mark on the skin, such as would be produced by a bullet glancing off a hard object. There were also marks through the fob, as of a bullet passing through it. The mark passed downwards and outwards. There was no abrasion. *The next morning when I saw him* *again there was a considerable bruise*, showing the violence with which he had been struck. *There is no doubt that but for the watch the shot would have proved fatal, as it would have penetrated the bowels.*'

"A gunmaker's assistant deposed to the prisoner trying to buy a cheap revolver, but objecting to pay seventeen shillings.

"Mr. Venables, a gunmaker at Oxford, deposed to selling the prisoner a revolver for eighteen shillings, and fifty cartridges for two shillings.

"*Mrs. Tarry* deposed to seeing the prisoner fire, and hearing the pistol fired five times. She also saw the prisoner struggle with Mr. Beesley. Another witness deposed to hearing five shots. There was some reason to believe the prisoner to be insane. On the next hearing, however, his conduct was rational. Superintendent Hedges proved finding a bullet in the piano, one which had struck a case of stuffed birds, and a bullet mark in a glazed advertisement in the shop, though that bullet could not be found. This, with the one in Miss Beesley's body, and the bullet found by the fireplace (probably the one which glanced off Mr. Beesley), accounted for five shots. Examination of the weapon showed that only five chambers had been loaded, and this agreed with the number of cartridges missing from the box which had held fifty.

"The prisoner was formally committed for trial."

In the *Pimlico Murder*, for which *Frederick Treadaway* was condemned to death, the prisoner first fired at John Collins in the neck, who died instantly, the bullet penetrating the spine. He then fired at Mrs. Collins, the wife, and the bullet struck her behind the ear [it could not be found for a few days, but was afterwards extracted, and she gave evidence at the trial, less than two months after]. Failing to kill her, he struggled with her, and beat her head on the ground. In this case the gunsmith deposed to making special cartridges for the revolver which a pawnbroker sold the prisoner. The ball produced was the same size as those in the cartridges given to the prisoner. For the defence it was alleged that the prisoner's grandmother was paralyzed, and quite childish several years before she died. One of her daughters died in Hanwell Asylum. Another relation was confined in an asylum, and he twice attempted suicide. Another sister of the grandmother was also quite imbecile. Several other members of the family had died in lunatic asylums, and one of them fell into the fire in an epileptic fit. The prisoner himself had a kind of epileptic fit during the trial. His father said that once before he had had something like a fit.* ["Lloyd's News," Feb. 11, 1877; and "Daily Telegraph," Feb. 7 and 8, 1877.]

Case VII.—*Death from a Telegraph Wire.*

"In March, 1876, Dr. Hardwicke opened an inquest at the Coroner's Court, Islington, on the death of William Stevens, aged thirty-nine, who was mortally wounded during the severe gale of Sunday last (March 5th). It appeared that the deceased was driving an empty omnibus to change the horses. He was noticed to be sitting on the box with his head hanging down. One of the witnesses climbed the box, and found him dead, with his throat cut from ear to ear! A policeman proved to finding the broken telegraph wire, which had caught deceased by the neck. Dr. Sansom found the head nearly severed from the body, and only attached by the spine. All the arteries and veins were exposed. The cut was above the throat, and so exposed the tongue. Death must have been almost instantaneous. There was a large pool of blood. Other witnesses deposed to the breaking of the wire; and one said that a gentleman had tied it round some railings in the hope of preventing the accident. But the contrary seemed to be the effect. Snow was falling at the time." ["Daily Telegraph," March 14, 1876.]

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* After the trial he had other fits of undoubted epileptic character, and the sentence of death was not executed.

CASE VIII.—*Fatal Explosion of Gunpowder at Hounslow. Death from Fire.*

["Daily Telegraph," Nov. 4, 1874, and following days.]

"Yesterday afternoon a shocking accident happened at Messrs. Curtis and Harvey's Gunpowder Mills, near Hounslow, by which four men were killed, and a man and a boy injured. Amongst the numerous buildings is a brick and slated structure, called "the mixing house," where the ingredients of the powder—charcoal, saltpetre, and brimstone—are separately brought to be mixed. For that purpose they are emptied from small bags into a cylindrical machine, or barrel, called 'the monk,' and then stirred until they are thoroughly amalgamated. The next process is taking the compound from the mixer, and placing it in bags, for the purpose of its being conveyed into the incorporated mill. It was in doing this the men lost their lives. The law only allows twelve charges, of fifty pounds each, to be mixed at one time in the building; yesterday, as the men were engaged in removing the mixture from the monk to a cart outside, and when eight charges remained in the house, by some means, at present unknown, one of them caught fire, and the rest being ignited, a terrific conflagration ensued, from the effects of which and the dense and deadly fumes there was no escape. *There was no explosion*, but a gradual burning of the mixture, accompanied by clouds of suffocating smoke, and myriads of sparks. Four of the poor fellows were suffocated and literally roasted before their bodies could be extricated. The building was thoroughly lined with wood, in order that no igniting substance should get precipitated on to the floor. The charcoal had been made six weeks. The machinery was copper. The place was swept two or three dozen times a-day. The men wear leather aprons, and sewn shoes, made of leather, and pegged. These shoes are only worn in the work. The platform outside is kept matted. The fire took half an hour, at least, to extinguish. A large portion of the saltpetre and brimstone did not explode, and was swept into the water. This was the more singular, as the floor was so thoroughly charred. No light was thrown on the cause of the accident by the inquest held on the bodies. All the inmates of the building died, so that no one could give evidence of what took place there."

"A fatal explosion of a substance called *mataziette* [far more dangerous than dynamite, *litho-fracteur*, or *tonite*, but like these made from *nitro-glycerine*] took place lately at Fort Lormont, near Portarlier, France. It is said to be manufactured in Switzerland. Its explosive energy is four or five times, at least, that of gunpowder. It exploded with such force as to destroy the fort almost entirely, and to throw down the barrack walls upon the Portarlier Railway, which it blocked up."

CASE IX.—*Homicidal Wound of the Throat. The internal Jugular Vein cut obliquely. Ligature of the Vein. Recovery of the Patient.*

[Case reported by Mr. John Woodman, in the "British Medical Journal," Oct. 18, 1873.]

"On August 14, 1873, between five and six p.m., Mr. Woodman was hurriedly called to see the matron of the Exeter City Workhouse, aged about thirty. One of the inmates, Thomas Snelgrove, was caught in the act of nearly killing her. She was seated in a chair, her clothes saturated with blood, her head supported, and pressure being made over the wounds with an apron. The hæmorrhage had temporarily ceased. Mr. Woodman had her taken upstairs, and found six wounds on the neck, three slight cuts on the face, and three cuts on the fingers of the right hand, caused in the struggle. All these wounds were such as would be inflicted by a razor, the instrument said to have been used. Of the wounds in the neck, two were slight, three severe, but not dangerous, whilst the principal one was situated two-and-a-half inches below the left ear, and extended three inches across the throat to the corner of the hyoid bone. Whilst sutures were being put to the other wounds, an alarming gush of venous blood came from the larger wound, which Mr. Woodman controlled by his fingers. He felt sure the internal jugular vein was wounded, but in the meantime, whilst waiting for assistance, examined the wound, and found that the external jugular vein, auricularis magnus nerve, and sterno-mastoid muscle, were completely divided, and the anterior spinal muscles exposed. On the arrival of Mr. Roper, Mr. Woodman removed his finger, and so great was the hæmorrhage, that it was extremely difficult to find the exact source. It was at last discovered to be a slit, about half an inch long, in the direction of the course of the vein, and *at a right angle to the external wound.* The descendens noni nerve was moved out of the way, and the lips of the wound in the vessel being held by torsion forceps, Mr. Woodman and Mr. Roper succeeded in tying the vessel, simultaneously, above and below the wound. The hæmorrhage was thus stayed. There was a little surgical fever on the fourth day, which soon subsided. On the fourteenth day a ligature round a small artery came away, and on the nineteenth and twenty-seventh days the lower and upper ligatures on the internal jugular vein came away. On the forty-third day the wounds were all healed ; and her recovery soon afterwards became so perfect, that she suffered scarce any inconvenience, except the look of the scar. It is singular, that, although very faint, the patient never quite lost consciousness. The operation of ligaturing the internal jugular vein is comparatively a rare one. Mr. Bryant, of Guy's, and Mr. Cooper, of the London Hospital, have, however, published cases, and there may be a few more on record. The direction of the wound in the vein is of interest, as showing that the razor must have been turned in the wound. She owed her life first to the pressure made by those who first ran to her assistance, and next to the skill of her medical attendants.

CASES X. and XI.—*Murders traced by means of the Hats worn by Victim and Prisoner respectively.*

[For the first case, *see* Dr. Taylor, vol. ii., p. 513; for the second, "The Modern Newgate Calendar," pp. 201—220, and the English newspapers for July, 1864.]

In *Regina* v. *Watson and Wife* (Notts Lent Assizes, 1867), the prisoners were charged with the murder of a man named *Raynor.* He was seen going to their house, and about two hours afterwards his dead body was found lying across a line of railway below it. Twenty minutes before a person passed the spot, and the body was not then there. The medical evidence showed that death resulted from manual strangulation. There were marks of bruises about the head. The face was smeared with blood, and blood had escaped from the nose, but there was no incised wound, and no injury to any large blood vessel. *No hat could be found.* There were marks of dragging between the cottage and the railway; and at one part in the soft clay the impressions corresponded to the boots worn by the male prisoner. There were marks of blood on the top bar of the gate. On searching the house, *an iron rake was found concealed on a shelf!* This was given to Dr. Taylor for examination. A cindery substance, looking as if it had undergone fusion, adhered to one end of it. On heating a portion, the *smell of burnt shellac was emitted.* By acting on it with alcohol, a resinous solution like that of shellac was obtained; and on microscopic examination of some fibre-looking things separated from the alcoholic solution, they turned out to be the hairs of some animal of the *rodent* tribe. There were also flakes of resin. [Dr. Taylor figures the hair, fig. 107 of his book.] On burning a similar sort of hat, the cindery ash gave similar results. And it appeared that these hats were made of felt from *rabbit's and hare's* fur, combined with shellac! The male prisoner said he had used the rake to clear out a cesspool the day before the murder! The theory of the prosecution was, that the prisoner having murdered the man, hoped that a train, then due, would have gone over him. *But the train was late,* so that the porter found the body before its arrival. The hat was probably left behind in the cottage. There can be little doubt the prisoners burnt it, to try and conceal their crime. They could give no satisfactory account of the rake, or of the hat of the deceased, nor did it appear that shellac and rabbit's fur were used for any lawful purpose by them. Dr. Taylor remarks that it might have been more satisfactory had the prisoners been interrogated as allowed by the Scotch (and, we might add, the French) law. [For an account of the structure of various animal furs and hairs, *see* pp. 572-6. Chinchilla fur, one of the rodent's, is figured. Rabbit's hairs, being so common and easily procured, are omitted.]

In the case of Müller, who was executed for the murder of *Mr. Briggs,* on the North London Railway, suspicion was first excited by the prisoner *having left his own hat in the railway carriage and taken that of the murdered man!* The murder occurred on the night of Saturday, the 9th July, 1864, between Fenchurch Street and Hackney. Mr. Briggs was a banker's clerk; and two gentlemen entering a carriage at Hackney Station found the cushion smeared with moist blood. Mr. Briggs was soon found on the line, insensible, and he died soon after. His skull was extensively fractured; the cartilage of the left ear was severed; about an inch in front of this was a deep wound, extending to the bone; over the temple, a contused wound, superficial and grazed. There were several incised wounds on the scalp. "I think as many as four," said Mr. Toulmin, the surgeon. On the crown of the head an incised wound three inches long. There was effusion of blood between the scalp and the skull. This witness, and Mr. Brearton, the other surgeon, both attributed the wounds to a blunt instrument. The stick carried by deceased was a stout one, heavy at one end, and was a formidable weapon. The prisoner sold the chain of the deceased; and it would appear that he either altered the hat himself, or had it done. Mr. Digance, the hatter, identified the hat as like the one sold to Mr. Briggs, and made by him, except for the alteration. An attempt was made to prove an *alibi*, which was unsuccessful. Müller, when executed, said, "Ja, ich habe es gethan!" [Yes, I did it.] It has been suggested that trephining might have restored consciousness to Mr. Briggs, but this was an *ex post facto* idea, and must, therefore, be received rather as a hint for the future, than a subject of regret or censure for the past.

CASE XII.—*Identity established by a Finger bitten off in the Struggle between a Surgeon and Two Robbers.*

[Dr. Taylor, *loc. cit.*, p. 525, vol. ii.]

"Mr. Smith, a gentleman who formerly attended my lectures, communicated to me a singular case in which identity was established by the production in evidence *of a portion of a finger belonging to the assailant.* In 1834 two men were charged with having assaulted the prosecutor, a surgeon, with attempt to rob him. The prosecutor, whilst walking late at night along a lonely road in the country, overtook three men who were strangers to him. One knocked him down by a severe blow on the face and held him, while another put his hand upon his mouth to prevent him giving alarm. The prisoner contrived to get his finger into the prosecutor's mouth, and, during the struggle, *the latter bit off the end completely between the nail and the first joint.* The men then ran away. The piece of finger was given to a constable, and in the course of about eight hours he found one of the prisoners with his hand bandaged. On examining the hand, *the tip of one finger was missing.* The prisoner accounted for this by saying that he had accidentally *cut it off!* This statement was found to be false, and he made several other inconsistent statements. On comparing the piece of finger with the injured finger of the prisoner's hand, they were found to correspond closely. The portion of finger was preserved in alcohol for the trial, and upon this clear proof of identity he and his companions were convicted." [Other cases of the kind are on record. Beck gives one or two. And in a recent police-court case the assailant was identified by the *loss of the tip of her nose*, which her victim had bitten off and preserved!] Dr. Taylor gives another case in which a *wound of the knee*, produced by the recoil of the breech of a gun, was the means of identifying an assailant [*loc. cit.*, p. 525].

CASE XIII. — *The Bremerhafen Explosion. An Infernal Machine, regulated by Clock-work, explodes before its Time.*

["Dover Standard," Dec. 25, 1875; "The Watch-Maker," for Jan., 1876, &c.]

A man, called Thomas, whose nationality was disputed, conceived the horrible idea of blowing up a large steamer of the value of several hundred thousand dollars, and a great number of passengers, in order to gain a few thousand thalers by the insurance! He made his preparations for many weeks. At about eleven a.m. on the 11th of December, 1875, the *Mosel*, a large transatlantic steamer, was lying in the outer harbour of Bremerhafen, on the point of sailing for New York. Her passengers were partly on board, and partly on shore, where a number of people had collected to witness the departure of the vessel. The signal for weighing anchor had already been given, when a train laden with goods approached. The packages were quickly brought on board. When by means of the crane two cases and a somewhat pointed barrel were being wound on the ship, a terrible detonation, and an immediately following explosion, occurred. At first it was supposed the ship's boilers had burst. When the smoke had cleared, these were found all right. The crowd seemed to be blown all away. The side of the *Mosel*, entirely shattered and pierced with deep holes, was covered with blood and human limbs! Pieces of human bodies had been hurled to a considerable height in the air, and cast to some distance. Within a circle of about thirty or forty feet the landing-place was like a battle-field. There was a hole some six or seven feet deep in the side of the quay. The explosion was proved to be from *dynamite*. [*See* p. 1004.] It took fire in some way, and the result was more than sixty killed and over seventy wounded, more or less dangerously; the side of the *Mosel* bored through; and the deck of the *Sampson*, a tow-boat, destroyed. People were blown forty to fifty feet up into the air. All the windows were shattered on the quay, and even in the village of Geestemünde, some distance off, the shock was felt. At first Thomas appeared much shocked, and went about making inquiries. But in the evening groans were heard to issue from one of the cabins. When the door was broken open, Thomas was found in his shirt-sleeves, perfectly unconscious, and his face smeared with blood. He was found to be wounded in the head, and a six-barrelled revolver, from which two shots had been fired, was afterwards found under the sofa. After he recovered consciousness, he confessed the crime. It appeared from papers found on him, &c., that he had lived three weeks in Bremen, and hired a shed in the busiest part of the town, to prepare the explosive material. He ordered from a cooper a strong barrel of fourteen cubic feet, which he, by means of wood, divided into two parts. In the upper compartment he laid the dynamite, with several pieces of iron! In the lower and smaller compartment, he attached a kind of clock-work, which would, on being wound up, after a certain time (ten days*), set fire to a match, and cause the explosion. He had insured a number of packages and hampers. These cases were to be taken on board at Southampton, at which port Thomas intended quitting the vessel. There he also contemplated winding up the clockwork, so that after a few days' journey, when the steamer was on the ocean, every soul should perish. It is not yet known how the explosion occurred earlier than was calculated. After about twenty-four hours Thomas made a fresh attempt to commit suicide, by tearing away the bandages from his head. He was trephined, but died a few days after. The clock-work was made by a watchmaker named *Fuchs.* Thomas ordered a machine to go ten days, without ticking, and also that the elevation, or hammer, which should strike the hour when the clock had run down, should possess a concussive power of thirty pounds! Fuchs executed the order, and Thomas told him to make twenty more! He called the explosive material "polishing powder." He had wound up the clock on the day of the explosion, reckoning that he should have time to get away at Southampton! His wife appeared to be quite ignorant of his plans, and always thought him a good-hearted, kind, and pious man! It is said that the explosion was heard at Oldesloe, in Holstein, more than a hundred miles away.

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* "The Watchmaker and Jeweller" says, *twenty-four days*.

CASES XIV. and XV.—*The Murder of Harriet Lane, known as the Wainwright Case, or Whitechapel Tragedy.—The Identity of a Dismembered Body. Evidence from the Hair and Teeth. The Uterus doubtfully Multiparous. The "Thames Mystery" unsolved.*

In November, 1875, *Henry Wainwright* was tried for the murder of *Harriet Lane,* a woman with whom he cohabited. His brother was tried as an accessory, and a *danseuse* of their acquaintance was arrested on suspicion, but discharged without any imputation of guilt. Henry was afterwards executed. He was a brushmaker, of good education, and had led a moral and useful life for many years, until a few months before the crime for which he suffered. He murdered his victim by shooting her, for two bullets were found in her brain, and a third amongst her hair, flattened out against the skull; and he also cut her throat, through one carotid artery down to the cervical vertebræ. The crime was discovered by one of his workmen, who noticed a mutilated hand protruding from a badly-smelling bundle wrapped in American cloth. The prisoner was removing this and another bundle in a cab, and he was smoking to hide the odour. The *danseuse* referred to was in the cab with him. When a policeman could be found to stop the cab, it was discovered that one parcel contained the decomposed trunk of an adult female body. One side of the parcel disclosed the hand mentioned. The contents of the second bundle disclosed the head of a female, so covered with lime [and chlorinated lime] that it was difficult to guess her age. The arms and legs were also in the parcel. In the Whitechapel premises a new spade, soiled with lime, &c., and a grave under the floor, with disinfectants, were discovered. The poor woman had disappeared nearly twelve months before (September, 1874). She had had two children. The body had been cut into ten different parts. It was identified partly by some jewellery found on the premises. The body was partly mummified, partly converted into adipocere. The ten parts were, head and neck and two hands, two arms, one trunk, two thighs, two legs and feet connected. It was very roughly dismembered, so that there were parts of the pelvis with the thighs. The medical witnesses supposed her about twenty-five years of age (from the wisdom teeth), and five feet high. There were two distinct fractures of the skull, due to the two bullets. Mr. Larkin, the medical witness, first called, said very properly,* "One of the bullets had certainly entered during life, the one behind the ear." *Question.* "What led you to that conclusion?" *Answer.* "The extravasation of blood underneath the scalp for a considerable distance around the wound, having a diameter of about two inches, and also slightly *within* the skull, following the direction in which the bullet had gone." *The Attorney-General.* "Would either of those shots produce death? *Answer.* "Yes, not necessarily instantaneously." He also deposed, that owing to the extravasation of blood in and about the parts, the throat must have been cut either just before or immediately after death. Evidence was given as to her *teeth*, and also as to a *scar* on the right leg, by which her parents recognised her. "It was an elongated scar as big as a shilling, but the puckering or drawn skin was much bigger." It was such a scar as a burn, say from a red-hot poker, would produce." The bullets were flattened, but had been conical. One weighed 66 grains, one 78, the third 72 grains. *The hairs on the shovel were proved by Dr. Bond to correspond with those of the head.* "The throat wounds appeared to be homicidal, as it must otherwise have been done by a left-handed person." The gunsmith deposed that the bullets were either No. 320 central fire, or No. 297 rim-fire. This witness produced some revolvers which were suited to the bullets. Mr. Larkin gave it as his opinion that the deceased had had children, partly from the *lineæ albicantes,* partly from the appearance of the *uterus* [*see* p. 708, and the "British Medical Journal" for December 11th, 1875, No. 780.]

In the so-called "*Thames Mystery*" [*see* the "Daily Telegraph," and other newspapers of September 5 to 20 inclusive], fragments of a woman's body were discovered in various parts of the Thames, from Wandsworth to Woolwich. The legs had been divided into three parts each—thigh, leg, and foot; the two feet, each 9½ inches long, perfectly corresponded, as did the other parts. The shoulders had been cut by sawing through the clavicle and scapula, and were taken by the police for *thighs.* The arms had been divided into three. The scalp, face, &c., were skinned; the right and left breasts, the left half of the pelvis, the lungs, &c., were all discovered separately. The mutilation was done unskilfully; whilst some joints were clearly cut through, other parts were sawn with a fine saw; there were smears of tar on some parts of the body. Enough was found to make it probable that the woman's age was about forty. There was a scar on the left breast, 3 inches by 2, a light-brown mole on the inner side of the right nipple, a small mole on the right side of the neck; and a large wound on the right temple caused by a blunt instrument. There was rather short black hair on the head [8 or 9 inches long], and a thin dark moustache. There was a large bruise on the front of the right thigh; there were blisters, probably from heat and decomposition. On the front and inner surface of the right arm, near the elbow, there was a small scar, but near the right knee a large white scar, two inches in diameter. The surgeon who examined these remains came to the conclusion that the body had been cut up whilst still warm, and that the bruises were inflicted during life. The height was about 5 feet 3 inches.

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* The whole of Mr. Larkin's evidence was good, and was mostly supported by that of Dr. Bond. There was no rebutting medical evidence of any value.

It might have been thought that these scars and moles were ample means of identification. However, the mystery was never solved, and an open verdict of "Wilful murder against some person or persons unknown" was returned. The tar made some think a bargeman had done the deed; whilst others thought the fine saw pointed to a cabinet-maker or carpenter. It could not be attributed with any show of probability to a medical student, as it was in the recess; and again, the mutilation was far too clumsy for any one possessing the least knowledge of anatomy.

[*See* Dr. Taylor's book, vol. i., p. 131, &c., for a description and drawings of the several parts of Dr. Parkman's body.]

CASE XVI.—*The Murder of Mr. Weare, by Thurtell, Hunt, and Probert.*

[Hertford Assizes, December, 1823. *See* the "Modern Newgate Calendar," p. 318, &c.]

In this case a gambler was killed by his associates; Thurtell, the actual murderer, being assisted by Hunt and Probert, and the murder was deliberately planned. The murderers were arrested first on mere suspicion, but Probert turned King's evidence, whilst Hunt confessed the murder and disclosed the body. The body was found in a pool, quite naked, the head and body in a sack, with flints under each armpit, and a handkerchief full of stones tied to the cord that fastened the sack. The jaws and the left temple were driven in, as if with a pistol muzzle. There was a shot wound in the right cheek bone, two deep cuts half through the jugular vein on the left side of the neck, behind the ear, and another wound on the right side. A red handkerchief was tied round the neck of the corpse, as if to stanch the blood. Probert was afterwards hanged for horse-stealing. We notice this case, because we have here an example of those compound injuries which sometimes puzzle medical witnesses when asked which wound was inflicted first. For here there was—(1) A gunshot wound; (2) A severe contused and lacerated [battered] wound on the jaws and temple; and (3) Two or three wounds on the neck, of which those on the left side were enough to cause death. So that there were three injuries, any one of which might have been fatal, and the latter, in the absence of skilled assistance, must necessarily have been almost instantly so. The amount of blood lost might have aided us in coming to a conclusion. It is, of course, most probable, in cases like this and that of Harriet Lane killed by Wainwright, that the shots were fired first, and the throat cut after. The battering in of the temple, &c., was probably intermediate. In reality, when any one of two or three or more injuries would cause death, it is of little moment which was inflicted first. Yet, whether important or not, circumstantial evidence, and the amount of blood lost, with the appearances of the wounds, &c., will often enable us to decide this point.

MUTILATION OR MAIMING; OF THE CRIME KNOWN AS "MAYHEM" IN ENGLISH LAW; AND OF SELF-INFLICTED INJURIES.

The ancient Jewish law of equitable punishment: "And if any mischief follow, then thou shalt give life for life, eye for eye, tooth for tooth, hand for hand, foot for foot, burning for burning, wound for wound, stripe for stripe" [Exodus xxi. 23–26], was doubtless intended to put a check to the *unmeasured*, savage, and in fact brutal *retaliation* for injuries which prevailed amongst the heathen nations surrounding the Jews, and of which professedly Christian nations still furnish examples, as, for instance, shelling or bombarding a whole town or island for the murder of one or two white men! The French Code of 1791, and the Code Napoléon, even as modified in 1824, established a scale of punishments for such injuries, "as although not mortal are still incurable, and either leave permanent deformity, or weaken or destroy one or more of the functions of the body." Whenever anyone was so hurt as to be unable to do manual labour for the space of forty days, the criminal was directed to suffer two years' imprisonment. If arm, leg, or thigh was broken, three years were appointed, and four years for absolute loss of sight in one eye, a complete loss of a member, or a mutilation of some part of the head or body. It was extended to six years, provided there was absolute blindness, or a total inability to use either both arms, or both legs." [Beck, p. 648 ; from Fodéré, vol. iii., p. 427.] The present code [art. 309, *see* Fodéré, p. 428] does not contain these distinctions, but leaves a discretionary power to the judges to vary the terms of imprisonment. But it is perhaps more severe, since it prescribes *imprisonment* generally against whoever shall, either by wounds or blows, injure a person so that he is ill, or unable to labour, for the space of twenty days thereafter. And this imprisonment was for terms of five to ten years. By the Act of 1824, the Court may reduce this punishment. Huard, Orfila, and others justly urge that this period of twenty days is too short and too arbitrary. Orfila, Leçons ii., 422 ; Beck, *loc. cit.*, p. 649.] One mutilation, *viz.*, *Castration* [*see* p. 681], subjects the criminal to hard labour for life, and if the castrate die within forty days the castrator is to suffer death. [Art. 316.] Some exceptions are made.

The term *mayhem* is applied to this class of cases in English law. Our word *maim* is clearly derived from this [from *mehaigner*, old French *me*, like *mal*, badly, and *haigner*, as if *hainer*, for *haïr* to hate or be inimical to.[*]] Blackstone ["Commentaires" iv., pp. 205-207] defines it as "the violently depriving another of the use of such of his members as may render him the less able, in fighting, either to defend himself, or annoy his adversary. And therefore the cutting off, or disabling, or weakening a man's hand or finger, or striking out his eye, or fore-tooth, or depriving him of those parts, the loss of which in animals abates their courage, are held to be *mayhems*. But the cutting off his ear, or nose, or the like, are not held to be *mayhems* at common law, because they do not weaken, but only disfigure him." By the common law also *mayhem* has for a long time been only punishable with fine and imprisonment, unless, perhaps, the offence of mayhem by castration, which all our old writers held to be felony ; and this, although the mayhem was committed upon the highest provocation.[†] After sundry changes in our English laws came the '*Coventry*' Act, in the reign of Charles II., so called from its being occasioned by an assault on Sir John Coventry in the street, and slitting his nose, in revenge, as was supposed, for some obnoxious words spoken by him in the House of Commons. This ordains that if anyone "of malice aforethought, and by lying in wait, unlawfully cut out or disable the *tongue*, put out an *eye*, slit the *nose*, cut off a *nose* or *lip*, or cut off or disable any *limb* or *member* of any other person, with *an intent to maim or disfigure him*, he shall be deemed a felon without *benefit of clergy*."* By a law passed in the 43 George III. [*Lord Ellenborough's Act (?)*] all wilful and malicious *maiming*, stabbing or cutting, *with intent* to murder, rob, *maim, disfigure, or disable, or to do some "grievous bodily harm,"* is declared felony. By a law passed in the 9 George IV., chap. xxxi., it is enacted "that if any person shall maliciously *shoot at* another, or *cut, stab*, or *wound*, with intent to maim, disfigure, or disable, or to do some other 'grievous bodily harm,' it shall be deemed felony in all cases where, if death had ensued, it would have amounted to murder." [Lord Lansdowne's Act.] This Act is said to have originated in an attempt of one Howard to murder with a *blunt* weapon!

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[*] Blount ("Glossographia") derives it from the Latin *mancus*.

[†] Beck gives the following curious tariff from the old Anglo-Saxon laws ["Edinburgh Encyclop.," vol. ii., p. 94, American edition ; Beck, *loc. cit.*, p. 649, note : — "C. V. equals current value in coin of present day. Loss of leg or eye, 50 shillings, C. V., £250 ; a wound, causing lameness, 30 shillings, C. V., £150 ; ditto, deafness, 25 shillings, C. V., £125 ; nose-piercing, 9 shillings, C. V. £45 ; a front-tooth, 6 shillings, C. V., £30 ; an eye-tooth, 4 shillings, C. V., £20." [Money was in those days one hundred times as valuable as now at least.]

In 1721 *Mr. Coke*, a barrister, and *Mr. Woodburne*, were *convicted and hanged, the one for hiring and abetting, the other for actually slitting the nose of Mr. Crispe*, Coke's brother-in-law. Coke, with great effrontery, said that his aim was to murder, and when found guilty, asked if the nose could be said to be slit, within the meaning of the Act, when the edge of it was not cut through? To this the Lord Chief Justice, Sir Peter King, replied:—"It is true, the edge of the nose was not slit, but the cut was athwart the nose, which cut separated the flesh of the nose, and cut it quite through the nostril. This I take [he added] to be a slitting of the nose, and *the surgeon swore the nose was slit*." [Hargrave, vol. v., p. 211.] Beck gives numerous decisions on technical points connected with these Acts. *See loc. cit.*, p. 651. One *William Lee* was tried at the Old Bailey, in 1763, for attempting to *cut his wife's throat* with a razor while asleep. The wound was three inches long, but did not prove mortal. This was decided not to be an offence within the Coventry Act! It would now, of course, be held to be "grievous bodily harm." [George III., 43, or IV., 9.]

Dr. Taylor states that the late Chief Baron Pollock stated on one occasion that "*grievous bodily harm*" *would reasonably apply to such an injury as would render medical treatment necessary*." Again, in *Reg.* v. *Haynes*, Central Criminal Court, Sept., 1847, the judge held that "the *intent* of the prisoner was to be considered by the jury. It was not because serious injury was the result of a prisoner's act that they were therefore to infer his intention was to do that injury." The prisoner had kicked a girl in the lower part of the abdomen. The surgeon described the injury as most serious; at one time he considered the life of the prosecutrix was in danger, and she would suffer from it all her life in all probability. Yet, in consequence of the judge's ruling, the prisoner was only found guilty of a common assault! On the other hand, in *Reg.* v. *Davis* [Chelmsford Autumn Assizes, 1871], a half-drunken prisoner in a quarrel had suddenly stabbed the prosecutor, whose life was in danger for a fortnight, and he was laid-up for a month. Baron Bramwell, in commenting on the defence, that prisoner had no intent to produce grievous bodily harm, said, "the jury might satisfy themselves on that point, by looking to the circumstances of the case. Could a man inflict such a wound as this without having an intention to inflict grievous bodily injury? The prisoner was not so drunk but that he knew what he was doing, and all the circumstances showed premeditation and intention, the *nature of the wound*, the *weapon* used, and the *part of the body struck*, when an injury was so likely to be dangerous." The prisoner was found guilty of the intent. [*See* also *Reg.* v. *Maslin*, Devizes Summer Assizes, 1838.] Dr. Taylor justly remarks that the *intent* is usually proved by *non*-medical evidence. But there may be dying declarations. *See before.* [Taylor, p. 456.] Beck adds to his chapter on this subject of maiming a *résumé* of the laws of most of the United States. By the statutes of Delaware, North Carolina, Connecticut, Pennsylvania, Tennessee, and Vermont, *castration*, or cutting off all, or any of the genitals, is felony, and in the two first-named States punished with death.

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* A privilege of clergymen, exempting them from the jurisdiction of lay tribunals. As all who could read were called *clerks*, many laymen benefited by this; but as a layman was not allowed to receive this benefit twice, he was on claiming it branded with a hot iron on the left thumb. In England this only applied to felony. Benefit of clergy was abolished by 7 & 8 Georgii IV. c. xxviii. s. 6.

We must remember that many minor injuries are self-inflicted. In countries where conscription is enforced, it is customary for young men to mutilate their fingers and thumbs.* Even severe injuries are sometimes purposely inflicted on themselves by criminals who either wish to extort money, or to disarm and divert suspicion.

The case of *Maurice Roux*, who charged his master, *Mons. Armand*, with intent to murder him [*see* p. 955], is an example of the former. Those who cut the throats of others will often just scratch their own throat with a knife, to make it appear that they have been attacked. Sometimes they overdo their part. Numerous illustrations of *self-inflicted wounds* will be found in Casper, Fodéré, Beck [p. 31, &c.], Taylor (pp. 552—556), Paris, and others. One such case is given by Dr. Marc [in the "Annales d'Hygiène," vol. i., p. 257. These "Annales" contain many other cases of a similar kind in the different volumes]. A civilian, with an idea, as it would seem, of rendering himself so important to a relative as to secure his gratitude, pretended to have had a murderous conflict with some assassins, although no dead bodies could be found. His head was wounded longitudinally to the extent of about *one inch*, and in direction from *left to right*. Only the integuments were divided. His hat of soft felt was cut for nearly *three inches*, and in a direction from *right to left*. A cotton bonnet, and a silk handkerchief, which he wore under his hat, were also divided. So powerful a blow as to divide all these, says Dr. Marc, should have inflicted a less superficial lesion on the head. The knife used by him "in killing the assassin," had a thick covering of blood, as if daubed on.

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* *Poltroon* is said to be derived thus :—From *pollex*, a thumb ; and *truncare* to cut off, because the cowards of ancient days used thus to disable themselves. *M. Pomian* has given us the following :—"A Russian conscript was charged with boring the drum of his ear [membrana tympani], to escape military service. The accusation was supported by medical evidence. It was referred to a commission, including M. Pomian, who found, on careful examination, that the aperture, besides resembling those made by disease, was in the lower part of the membrane. Now as the meatus auditorius externus has a backward and upward direction, an artificial opening would most probably have been in the middle or upper part of the membrane : it was, however, at the bottom of it. On these grounds the man was acquitted."

Had he really used it to stab, the clothes, and flesh too, would have rubbed off some of the blood in withdrawing it, and what remained would be in longitudinal striæ. Dr. Marc deemed the whole case pretended, *the effect not corresponding with the force of the ascribed cause.*

As Napoleon was one evening in the Park of St. Cloud, a young man rushed towards him, with the cry of "*Assassins! Save the First Consul!*" He fell near the group which surrounded Buonaparte, and, on examination, he was found to have two wounds, from which blood flowed. He ascribed these to conspirators, but none could be found, though the gates were closed almost instantly. Fifteen years afterwards he confessed that the wounds were self-inflicted! [Beck, p. 33; "Ann. d'Hygiène," vol. xi., p. 188.]*

It is not only possible, but probable, that in many cases of maiming, deformity, &c., produced by accident, your opinion may be sought as to the *amount of compensation* to be awarded for such and such injuries. Railway companies often request medical men to fix the compensation in cases not going to trial. And employers of labour, and others, often beg the friendly aid of the surgeon to say what sum of money should be given to workmen, or others, who have been accidentally injured in their employ, or by their means, or by their servants.† Although the School Board of London lately gave £200 in trust, absolutely, for the benefit of a child whose eye had been accidentally put out by a pen in the hand of a pupil teacher, we do not think that there are materials for a tariff of such compensations which would meet with general approval. Each case *must be studied on its own merits,* and compensation given accordingly. In estimating *damages* of this kind, you must regard and allow for:—

1. Necessary expenses and loss of time whilst the wound or injury is healing. Medical or surgical care ought, of course, to be paid for in this way, and all reasonable items for apparatus for crippled limbs, &c.

2. The station in life, mental characteristics, general intelligence and acquirements, and the occupation (if any) of the injured person, must all be carefully considered. In the case of a child, the rank or station must be fixed by that of the parents and guardians. To an artist, or first-class mechanic, a slight damage to one eye or a finger may be of far more consequence than the loss of a whole left limb might be to a labouring man.

3. The previous "earnings," or at all events, previous condition of the injured person, must be taken into account, along with the matters mentioned under No. 2. A *prima donna,* a first-class actor, a fashionable physician, or a successful author, may be earning their £10,000 a year before the accident. Therefore, do not look only to the *name* of the profession or trade.

4. In the case of females of almost all ages and ranks, and in many men, we must not forget that *deformity* is a serious detriment to success in life. It may, in the former case, either prevent marriage, or cause this to be less fortunate; and it may, in both sexes, be a bar to employment or to success in business. Even such a skin disease as

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* Castration is frequently a self-inflicted mutilation. Generally the penis is amputated simultaneously with the testicles.

† The driver of a cab or carriage is the servant of the owner. The latter is responsible for his servant's carelessness.

eczema has been known to make people commit suicide from the difficulty of getting employment. A noseless person, unless fitted with an artificial substitute, could scarcely hope to get any but the most menial employment. In the case of the eye, do not forget that injury to one eye is apt to cause damage to the other [it is said by sympathy;] in any case, the fact has been too often noticed to be denied. Unless the useless eye be entirely removed, and sometimes even then, the healthy and unhurt eye will often begin to ache, and fail, and show other signs of suffering.

L'ENVOI.

Dark and devious as are the ways of crime and criminals, stealthy and secret as are the steps of the poisoner and the assassin, yet there are few cases of crime on which the science of Forensic Medicine cannot throw a flood of light. Although some of the subtler alkaloids and rarer poisons present difficulties in their detection which severely tax the highest energies of the toxicologist—whilst questions of personal identity, or the origin of certain appearances in the dead body, may prove no less puzzling to the skilled medico-legist—yet no medical man, engaged in actual practice, can be certain that he may not be called upon, ere the day is out, to decide some one of the questions we have discussed. To attain special eminence in this department, requires special study, but every medical practitioner ought to know the general principles of forensic medicine. And other things being equal, he will be the best medico-legist who brings to his work a thorough practical acquaintance with his art, a keen eye to observe, an impartial mind to reflect and decide upon the facts of each case; and whose first aim is not to distinguish himself in the witness-box, or in the columns of the daily press, but to discover and confirm truth. It is truth in facts, and truth in words, which will on the one hand lead to the conviction of the guilty, and on the other, which is surely no less important, to the acquittal of the innocent.

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ADDENDA.

Edmonds v. *The Prudential Assurance Company.*—Mr. Edmonds has kindly informed us that on the 16th May last (1876) the Supreme Court of Appeal, consisting of the Rt. Hon. the Master of the Rolls, the Rt. Hon. Lord Coleridge, Chief Justice of the Common Pleas Division, and the Hon. Mr. Baron Pollock, set aside the verdict of the jury at Croydon, on the ground of the misdirection of the Lord Chief Baron; thus establishing Mr. Edmonds' case, and confirming the statement made in the note to page 612.

Mr. Haynes Walton, writing to the *Times* under date January 3rd, 1877, says that although colour-blindness is generally congenital, *it may be acquired.* One railway accident was due to the engine-driver having been thus affected. His sight had been tested some years before.—*See Remarks on Colour-Blindness, or Daltonism,* pp. 858 and 914.

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